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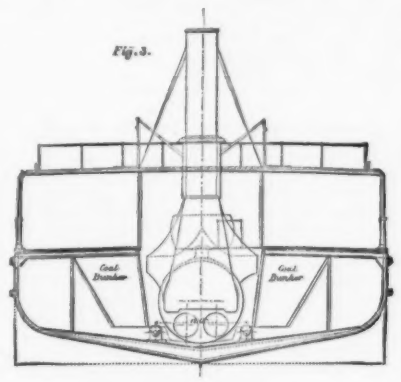
## NEW FERRY BOAT.

We give herewith engravings and description of the English idea of a steam ferry boat, being the very latest style, for which we are indebted to *Engineering*. It will be seen that John Bull has not reached the idea that it is desirable to shelter either his passengers or animals:

It has been computed that over twenty millions of the water-traveling public annually use the ferry boats on the river Mersey. These ferries, eight in number, terminate on the Cheshire shore, at points situated between New Brighton and Eastham, but all converge to the famous landing-stage on the Liverpool side. New Brighton is much frequented during holiday times, and the ferry to that place, together with the Egremont and Seacombe ferries, are the property of the Wallasey Commissioners, who have recently made extensive and important improvements for the accommodation of the public, especially as regards the goods traffic. The most noticeable feature of this is the addition of a double twin-screw steamer, the Wallasey, for the purpose of carrying goods, carts, carriages and cattle across the river from Liverpool and Seacombe, this vessel being the same type as the Oxton and the Bebington, two steamers which had already given excellent results on the Woodside ferry service.

The goods traffic at the Woodside ferry was formerly carried on by two paddle-steamers, and much delay used to be caused by the inconveniences attending the mode of loading and unloading wheeled vehicles, it being necessary to remove the horses, and to get the carts, etc., on board by manual labor. Moreover, at most, six loaded carts could be carried at each trip. In August, 1879, however, a material improvement was made by the placing on the station of the steamer Oxton, this being a double twin-screw steamer constructed by Messrs. Simons & Co., of Renfrew, for the late Birkenhead Improvement Commissioners, who were then the owners of the Woodside ferry. The Oxton has two screws at the bow and two at the stern, and the credit for this arrangement of her propelling machinery is due to Mr. James Taylor, of Birkenhead, at whose suggestion it was adopted. The navigation across the Mersey is at times very difficult, owing to the number of vessels at anchor, the heaviness of the traffic, and the occurrence of fogs, and hence handiness of maneuvering is a property of great value in a ferry steamer. This property the Oxton and her sister vessels possess in a very high degree, the double twin screws, driven by two pairs of independent engines, enabling them to be taken to and from their berths with great facility, and to be at all times very promptly handled.

Fig. 3.

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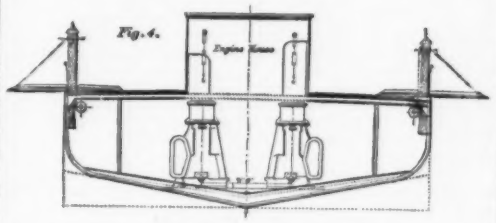



DOUBLE TWIN-SCREW FERRY STEAMER.

When the paddles were in use on the Woodside ferry the tariffs were high but on the Oxton being placed on the service they were reduced one half, and they have since been further reduced. These reductions in the tariff, combined with more frequent service, and the great facilities for prompt loading and unloading with steam-worked gangways, have resulted in an enormous increase in the traffic receipts, and there is every reason to believe that these receipts will increase still further. The saving of fuel effected by the Oxton as compared with the paddle boats was very important, the paddle boats averaging 10¼ cwt. of coal per hour, while the average consumption of the Oxton was but 3¾ cwt. per hour, the speed being at the same time somewhat higher.

In the course of the year 1881 some experiments were made on the Oxton to determine the effects of the bow screws. A counter was placed on the screw shaft, and trials were made as follows: 1st, with four screws, two acting as "pullers," and two as propellers, the two bow screws having the backs of the fans acting on the water; 2d, with bow screws removed and the remaining two at the stern acting with the face of the fans on the water; and, 3d, with two enlarged stern screws also acting with the face of the fans on the water.

The success of the Oxton led to the construction of the Bebington, of which we give several engravings in section and elevation, our illustrations having been prepared from tracings kindly supplied by her builders, Messrs. William Allsup & Sons, of Preston, who are also the builders of the Wallasey, to which we have already referred. The Bebington, like the Oxton, is arranged for the side loading of vehicular traffic, whereas the Wallasey, which has been made to suit the special requirements of the hydraulic arrangements at Seacombe, has doors at each end for loading end on. It may be noted, however, that the stability of the Oxton and Bebington is so great that they can safely take in on their side gangways heavier loads than are permitted by the by-laws of the Mersey Docks and Harbor Boards to pass over their landing-stages.

With the exception of the difference in the loading arrangements just mentioned, the Bebington and the Wallasey are of the same general design, but the former is 10 feet shorter than the latter. The Wallasey is 140 feet long by 45 ft. beam and 13 ft. deep, with a freeboard of about 6 ft., which brings her main deck nearly level with the decks of the stages. She is driven by two pairs of independent vertical compound engines of about 45 nominal horse power

Fig. 1.

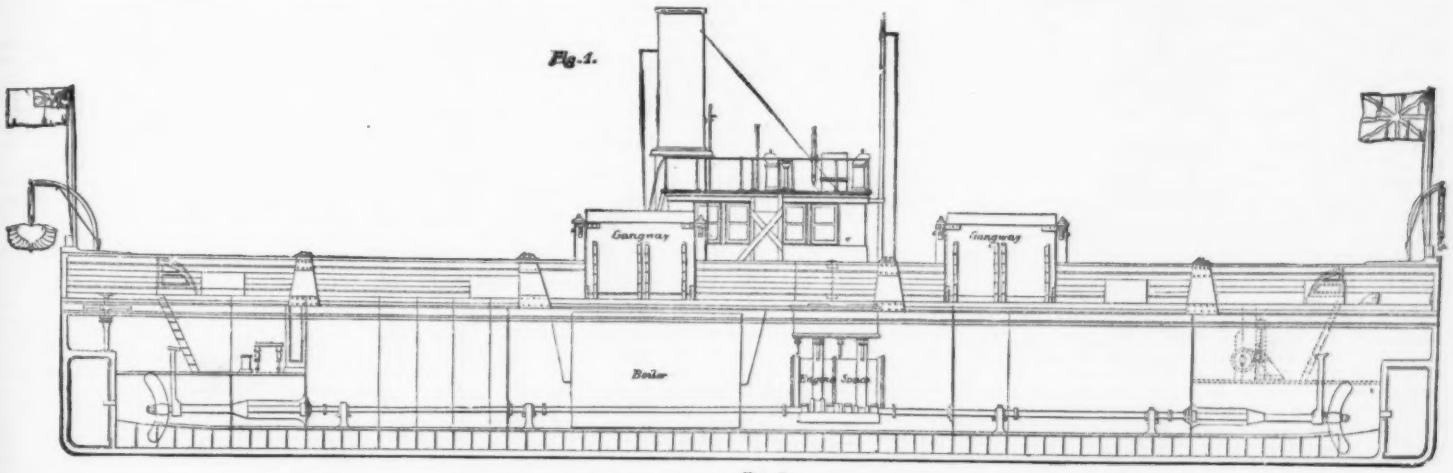
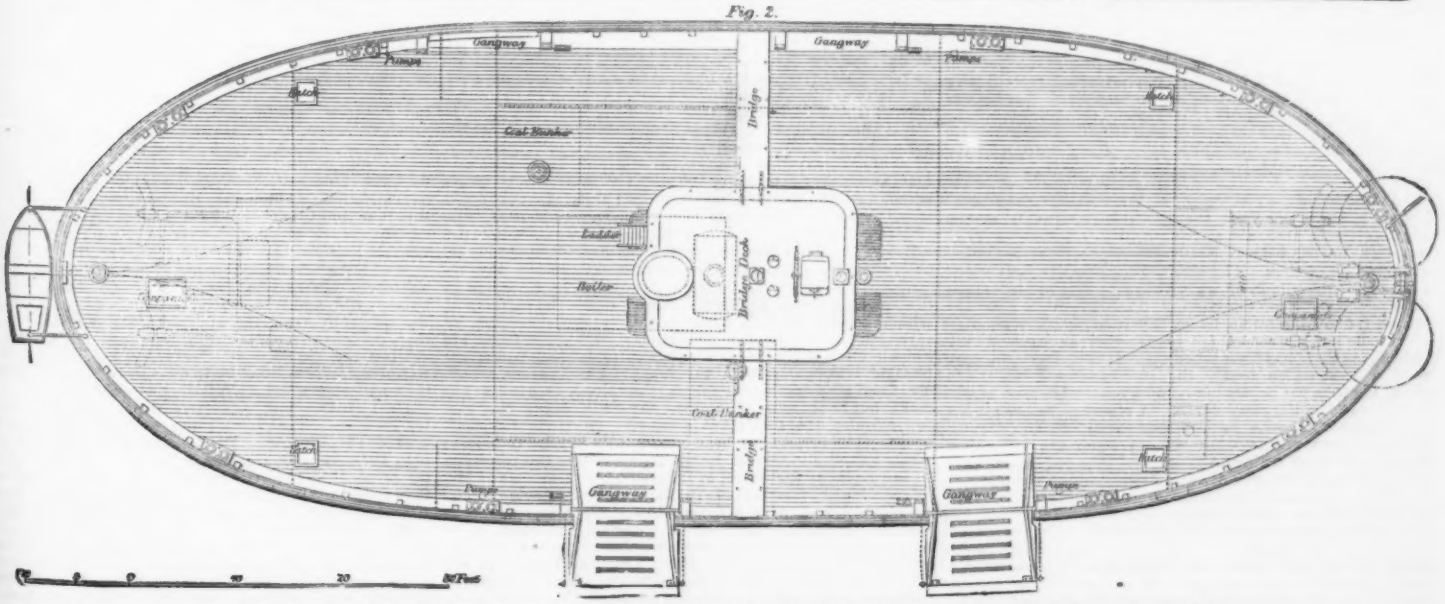



Fig. 2.




DOUBLE TWIN-SCREW FERRY STEAMER BEBINGTON—MERSEY FERRIES.

each, there being one pair of engines for a line of shafting passing right through either side of the vessel. These lines of shafting pass through both ends, and have a screw propeller at each end, two acting as pullers. It is believed that the bow screws, working as they do in undisturbed water, do the major part of the work.

The Wallasey is fitted with steam-steering gear, and this, combined with the independent working of her twin screws, gives her exceptional handiness. During the last Easter and Bank holidays there was such a pressure for passenger accommodation to New Brighton that it was found necessary to make use of the Wallasey to relieve the immense crowds congregated on the stage. This boat, although constructed for goods, is certified by the Board of Trade to carry about 1,760 passengers. She has no saloon, so the passengers had to put up with open-air accommodation. It was reported that considerably over 2,000 people were on board at times; but notwithstanding this great concourse of people, she seemed to go very steadily, and all the faster with her propellers well immersed. The Oxton and the Bebington, which now belong to the Birkenhead corporation, are also both certified by the Board of Trade for carrying passengers, the former vessel being licensed for 1,427, and the latter for 1,589.

The Wallasey has now been at work since December last, and for that period it has been ascertained that she consumes 3 tons 11 cwt. of coal per day of twelve hours, whereas the newest of their paddle-boats burn 4 tons 14 cwt. for the same number of hours' work. This being so, the screw boat appears capable of carrying her full complement of passengers, upon 45 lb. of coal per 100 passengers, continuously, whilst the paddle-boat under the same conditions consumes 109 lb. of coal per 100. Altogether, the economical working of the Wallasey, combined with the greater safety from collision due to her great handiness, the absence of paddle-boxes, and the adoption of a form of hull capable of subdivision into a large number of watertight compartments, renders the vessel entitled to be regarded as a decided advance in the accommodation of river passenger traffic.

## WIRE ROPES.*

By A. GARCENOT.

THE substitution of wire for hemp ropes in winding shafts is generally attributed by the author, who is engineering inspector of stores for the Anzin Company, to the increased depth of the pits, and to the inadequacy of the machinery for winding with hemp ropes. As the breaking strength of best round hemp ropes ranges between 5 and 6¼ tons per square inch of net section, while best round iron wire ropes are from six to seven times as strong and about six times as heavy for the same net section, it follows that round ropes of equal strength are also of nearly equal weight per yard, whether made of hemp or of iron wire.

After describing minutely the construction of flat hemp ropes, and also of wire ropes both round and flat, the author confines his attention to flat wire ropes, which for winding are sometimes made as much as 1,200 yards long, though ranging mostly between 400 and 800 yards long. By way of taper, the full sectional area is generally retained throughout half the length of the shorter ropes, and is succeeded by a smaller section in the remaining half; while in ropes of 600 yards and upward three sizes are employed, each for 200 yards length and upward: The big end has eight to ten wires in each strand, the middle length one less, and the small end six to eight. The iron wire ranges from No. 13 to No. 11 Birmingham wire-gauge (0·71 inch to 0·118 inch thick), the usual thickness being No. 14 or 0·087 inch. In ropes of steel or phosphor bronze the wires are No. 16 to No. 14, and in small steel ropes even No. 17½ or 0·059 inch.

*Flat Iron-wire Rope.*—As a fair example, a flat iron-wire rope of 700 yards length, suitable for winding from about 500 yards depth, is ordinarily composed of six hawsers, stitched together alongside; each hawser consists of four strands, which are laid with left-handed twist in three of the hawsers and right-handed in the alternate three; each strand commences with ten wires at the big end of the rope, and, omitting one by one, terminates with six wires at the small end; the wires are No. 14 gauge or 0·087 inch thick, and are laid spirally without twist around a core or heart consisting of a small strand of tarred or greased hemp. The stitching of the hawsers together is done by sewing them through by hand, in a zigzag direction, at 2⅜ inches pitch, with fifteen wires of No. 14 gauge; these wires are either laid singly side by side, as a thin flat band of 1·3 inch width, or are twisted together in threes, forming a narrower but thicker band of five round strands. The latter, or round stitching, is quicker though harder for the workman to do, and does not bind the two outside hawsers nearly tight enough to the inner ones. With the flat stitching, though always done much tighter than the round, the tightness of the several wires is often unequal; which interferes with the uniform stretching of the hawsers under the load in regular working, and is one of the principal reasons why flat ropes twist when hanging down the pit. The tighter flat stitching also materially increases the stiffness of the ropes, in comparison with the round stitching. Tables are given of the widths and thicknesses of the ropes with the two kinds of stitching, at its big end, middle, and small end.

*Load and Jerks.*—The weight of the sample rope averaging about 14 lb. per yard, the gross load upon it at the winding drum amounts to 8 or 9 tons, on starting without jerk to wind from 500 yards depth a loaded cage weighing 5 to 6 tons. The strain would thus be only about 7 tons per square inch of wire section. But in pits where the average speed of the cage is from 20 to 23 feet per second (14 to 16 miles an hour), the rope is often running at 26 to 30 feet per second (18 to 20 miles an hour) by the time all its slack has been taken up. It then starts the cage with a jerk, which brings the strain at the drum up to about 13½ tons per square inch, and stretches the rope nearly 1½ yards in the 450 yards depth. A rope exposed to such a jerk would work with perfect safety. A detailed investigation is given of the work thrown upon the individual wires in the rope, owing to their spiral form; of the pressure they exert upon the core of each strand; and of the pressure exerted by the strands upon the cross-stitching wires. The splicings of the wires almost always occur within the middle 200 yards of a rope 750 yards long. Testing proves that the loss of strength due to the splicings is about 10 per cent.; whence the desirability of using wires long enough to do without splicing, and so to allow of making the rope nearly 40 per cent. lighter for the same strength.

*Cross-stitching Wires.*—The pressures produced laterally upon the different kinds of cross-stitching by the bending of the flat rope in its passage over a pit-head pulley of 10 feet diameter are investigated and tabulated; they are smallest in the case of a single thickness or layer or flat stitching, and greatest with a double layer of round stitching. In winding upon the rope roll, each successive coil has to slip sideways, right and left alternately, so that its component hawsers may lie in the furrows between those of the next coil beneath. The strain thereby thrown on the cross-stitching is shown to be independent of the diameter of the component hawsers sewn together into the flat rope, and is directly proportional to the strain on each of them; whence a larger number of small hawsers in a flat rope is preferable to a smaller number of larger ones, as regards the durability of the stitching—a conclusion confirmed by experience. Allowing four to eight coils in reserve on the rope roll when the cage is at the pit bottom, an elaborate calculation is given of the continuously diminishing strains upon the successive coils in winding up, and of the corresponding strains upon the cross-stitching. From the copiously tabulated results it is inferred that in a new, good, and well greased rope of the dimensions already given, the tension upon the cross stitching wires in the coils on the rope roll would range between 6 and 20 tons per square inch. Most flat wire ropes in France are sewn with annealed iron wire from the Franche-Comté Works, which has an average tensile strength of fully 20 tons per square inch, and stretches 25 per cent. before breaking. When coiled on the roll therefore, with the maximum strain of 20 tons per square inch upon the cross-stitching, the outside hawser overhanging the coil beneath will have a very great tendency, even in a new rope, to part company from its neighbor, wherever not kept close up to it by the forks or guard arms of the roll. However small the lateral clearance between the roll arms and the sides of the rope the outside hawsers will thus gape from the rest of the rope when winding upon the roll, particularly at the parts corresponding with the starting of the cage from the landing places in the pit; and in lowering the cage the hawsers will be closed up together again by a tension upon the rope as it uncoils from the roll. Moreover the minute stretching of the rope strands, every time the load of the cage comes on them, must inevitably cause friction between themselves and the cross-stitching wires, with consequent wear of both. The stitching gives way first, and ropes often come unsewn through long lengths. Hence the necessity for keeping flat wire ropes well greased in working, and for carefully examining them often enough to guard against rusting.

*Experiments on Strength of Wire.*—In twenty-two voluminous tables, with copious comments, are given the details of an extensive series of experiments upon different kinds of wire employed for ropes: steel wire and iron wire, each galvanized and non-galvanized; iron wire annealed; and phosphor bronze wire, both unannealed and annealed. The wires were procured from various places, including Sheffield, Birmingham, Manchester, Cologne, Franche-Comté, and Anderlecht-les-Bruxelles. They were tested not only for tensile strength and stretching, but also by torsion, and by bending backward and forward at right angles on an edge rounded with 0·2 inch radius; they were flattened out under the hammer into thin ribbons, and were also hammered square, as a test of freedom from liability to splitting or cracking. The general conclusion drawn by the author is, that steel wire is the most advantageous for the rope strands; while the annealed iron wire from Franche-Comté, or annealed mild steel wire, forms the best sewing for flat ropes. For the strands of winding ropes, whether flat or round, the steel wire should possess a tensile strength of from 70 to 95 tons per square inch, taking no permanent stretch under 30 to 45 tons per square inch, and stretching only 2 to 4 per cent. before breaking.

For convenience of comparison, the arbitrary Nos. of the French and English wire-gauges, equally barbaric and mutually incommensurable, are tabulated side by side, with their equivalent sizes in millimeters.

* From the "Bulletin de la Societe de l'Industrie minerale," 1880, vol. ix., pp. 695-798; through "Min. Proc. Inst. Civ. Eng."

## THE WATER-SOFTENING PROCESS.

THE important question of the softening and purifying of hard water in bulk has received a satisfactory solution in the Atkins process, which promises to be of great public service in these respects. This process is a modification of and an improvement upon the old Clark system of softening water, which consisted in adding lime to the water to be softened, and allowing the mixture to stand for twenty-four hours in large reservoirs or precipitating tanks before it could be used. In the Atkins process, however, the precipitating tanks are dispensed with and the water can be used as it is softened, the process being continuous and no time being required for it to stand and settle. The process essentially consists in chemically purifying the water instead of mechanically, as in ordinary filtration. In practice, a small jet of lime water is introduced into a portion of the water to be softened, and the two are blended in a mixer, whence they flow into a softening tank into which the bulk of the water is conducted. From this tank the water with the lime in suspension flows into Atkins rotary disk filters, in which the solid particles are all arrested by an ingenious system of cloth-covered disks placed within a tank, and which present a very large area for filtration within a very small compass. The purified and softened water is conducted from the filters to storage reservoirs ready for use. The effect of the lime water is not only to purify and soften the water in bulk, but to cause any clayey matters that may be held in suspension to coagulate, thus facilitating their removal. The water passes from the outside to the inside of the filters through the cloth-covered disks, the surfaces of which become in time coated with a deposit consisting of carbonate of lime and impurities. These surfaces are quickly cleaned by means of a series of brushes which are brought into contact with the disks. The brushes, which are fixed on a spindle, are rapidly revolved, as are also the disks, but in opposite directions, the result being that in a few minutes the filters are cleansed and ready for work again. The system has been successfully applied to private water supplies in several instances, notably at the residence of the Duke of Richmond at Goodwood, and at that of Mr. W. H. Smith, member of Parliament, near Henley. The first application of the system to a public water supply is that of the Henley-on-Thames water-works, which were recently opened. It was introduced there by the engineer to the water company, Mr. Jabez Church, in consequence of the extreme hardness of the water, which is obtained from the chalk, and is normally of about 19° of hardness. After treatment, however, by the Atkins process the hardness is reduced to nearly 4°, which means a beautifully soft water. The apparatus is calculated to soften and purify rather more than 100,000 gallons of water per working day of 10 hours. The softening apparatus was supplied by the Atkins Water-Softening and Purifying Company, of No. 62 Fleet street, London. The system has been tested on the London & Brighton Railway by Mr. Stroudley, the locomotive superintendent, who is having an apparatus put up to soften and purify between 300,000 and 400,000 gallons of water per day for the supply to the boilers at the company's locomotive and carriage works at Brighton. The practical value of the system is, therefore, established as regards the treatment of waters containing carbonate of lime.—*London Times.*

## TOWERS.

AT the recent meeting of the Lincolnshire Diocesan Architectural Society, a paper was read by Sir Charles Anderson on "Towers." Sir Charles said: To build a good tower is a very difficult thing; he might say the main conditions for a good tower are proportion, and how to arrange the belfry windows and the upper part of the tower, which has always been a difficult matter, even with the old architects. Every tower has, he believed, a physiognomy, of which the belfry windows may be called the eyes, and the hoodmoulding the eyebrows. When the tower is narrow a single belfry window of two lights is preferable to one of three lights. He had seen some of three lights, generally in Early English towers, and he thought as a rule they are not good-looking. He thought double windows are infinitely more effective when the tower is sufficiently wide to admit of them, and the bolder the hoodmoulding the better. They had seen all those that day with regard to the mouldings even in those churches which have only single belfry windows; for instances, such churches as Moulton and several more. He was not speaking of spires, but of the tower only, whether it has pinnacles, or whether it has not; and they had seen several beautiful single belfry windows that day. Sir Charles asked his hearers to compare all the three towers of Lincoln, the great tower of York, the towers of Canterbury and of Gloucester, and the west towers of Wells; and he thought they would consider they are superior to any of the towers that have only a single window, such as the other towers of York and some others. Especially contrasting in that respect the tower of Boston, their neighbor, the upper window—the large window at the top—is inferior in beauty to the double windows below; but of that he would speak hereafter, for he conjectured there was a reason for it. He would confine himself to the towers of Lincoln, which most of them would probably be acquainted with. With regard to proportion, he believed that all towers ought to diminish as they rise, either by buttresses, such as they had seen in some of the towers that day, or by other treatment. Let them take Pinchbeck, Boston, the west towers of York and Beverley, and compare them with other towers which have no buttresses—he was not speaking of buttresses like the towers of Lincoln, which have no step buttresses, but diminish gradually as they go upwards. The towers of Lincoln were not built at the same time; the upper parts both of the great tower and the western towers have been added; but it will be found that the upper portion is not so wide as the lower portion. For instance, in the western they find the Norman work is of a wider square than the upper part—the later part; and it is that stepping in which gives them that beautiful taper and makes them so pleasing to the eye. And especially with regard to the great tower, they would find the upper part, which was built all at once—the very ornamental Decorated part—is raised upon an earlier portion of Lancet work; but the Lancet work below has a larger square than the upper part. In speaking of the great tower of Lincoln he would contrast it with the largest of modern towers, one which he did not specially admire, and that was the great Victoria tower at Westminster. His reason for not admiring it is that it appears rather top-heavy—a larger square at the top than at the bottom. Sir Edmund Beckett says it has the appearance of splitting at the top, and for this he gives an optical reason. But it has another objection, which is that the windows which stand in the place of what would be belfry windows are three in number, and he did not think the position of these is good, for a great deal depends on the position of belfry windows. After he had read Sir E. Beckett's book he asked Mr. Higg as to the great tower of Lincoln, and the latter replied that it was gathered in about 25ft. above the pinnacles, and it was that which gave it its beautiful appearance. Donington is gathered in. Boston is gathered in, and this (Sir Charles thinks) is the finest tower we have in England. It has only one defect, and that is the very large —what he would call coarse—window which is open underneath the lantern. He believed there was a reason for that, and he thought if they had not had the intention of making it a lighthouse that feature would have been differently treated. He had no doubt that it was intended there should be a light there, and he believed there was a light years ago to guide mariners over the Boston Deeps as well as to serve as a beacon over the Fens. He thought the first intention was to put a light in that great window, and that that was the reason it was made so large and open and free from ornament, for it has no cusps about it. If a light were put in a square, when the angles were turned to us, we should see no light at all. When they went up to try it, they found the light could not be seen at the angles of the square, and having found out that, they decided not to pull down what they had built, but to alter the plan and raise an octagon lantern, which would obviously be better for the light. Sir Charles thought that was the reason of that bald window over what he otherwise thought is one of the finest towers in existence. There was always a reason for what the old builders did, and with regard to the towers of Lincoln that was perfectly true; the architects had managed to make there one of the most beautiful buildings in England. Discussing the question of pinnacles, Sir Charles said there was always great difficulty in finishing a tower. The mistake we make now is in building the pinnacles too large. There are many towers that look better without pinnacles—Gedney, for instance. The great tower at York could not be improved by pinnacles. He believed York intended to beat both Durham and Howden by adding another story above the present; and the reason it was not done so was because they found the piers were not solid; they are mere casings of Norman work below, and Norman work is mostly very weak. They bored them some years ago, and they found the interior was mere dry rubble, which is often the case in Norman piers. He understood that one of the finest towers in the South of England (Pershore Abbey) has had pinnacles put to it, and that they are much too high, and have quite altered the character of the building.

## THE RECORD TOWER.

IN 1867 all the designs contributed in the great competition for the New Law Courts were illustrated in the *Building News*, and among these we published some drawings of Mr. G. E. Street's selected design. Several drawings were submitted, however, by Mr. Street, showing parts of his magnificent design which, till now, have never been published. The now-abandoned Record Tower, originally intended for erection at the N. W. corner of the site next Clement's Inn, forms the subject of one of Mr. Street's masterly drawings, while an alternative design of the same tower furnishes another picture. This sheet also shows the west elevation of the main block, as at first intended. Few will regret the change which has been made in the general design of the Law Courts, and especially in the management of the central hall, which now runs north and south instead of east and west, as the first plan proposed. All must, however, join in the regret which we have so frequently expressed at the abandonment of the Record Tower. The author's own drawings of so notable a design, therefore, will even be of more than ordinary value.—*Building News.*

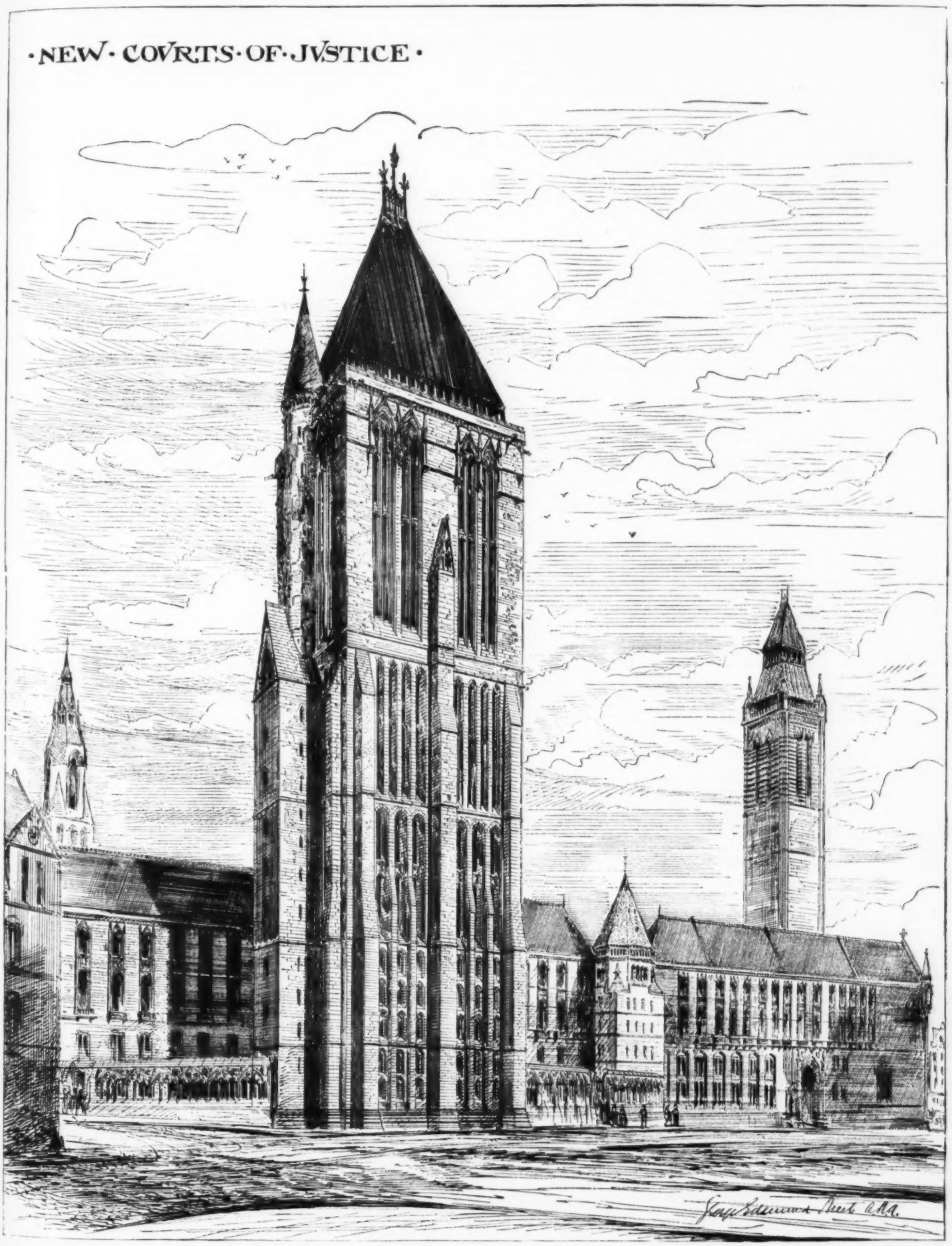
## THE PROGRESS MADE IN SECONDARY PILES.

EVER since attention was attracted to the industrial applications of the secondary pile, by the modifications introduced into Planté's apparatus by M. Faure, a number of so-called practical forms of the accumulator have made their appearance. We have called attention successively to the accumulator of M. de Meritens, to that of Messrs. Pezzer & Carpentier, and to that of Mr. Sutton; and we have likewise pointed out the form given by M. Reynier to the Faure pile.

Since the appearance of these, a few other arrangements have been devised, and the principal of which are that of M. de Méritens (new style), that of M. de Kabath, that of Messrs. Sillon & Wolckmar, and that of M. de Chanzy.

In M. de Méritens's old accumulator the leaden electrodes were arranged like the leaves of a book. In his new arrangement they are disposed like a window blind, the strips corresponding to the slats of which are horizontal, very thin and nearly touch each other; the whole forming a complex plate 30 centimeters in height, 25 in width, and about 1 in thickness. Each accumulator contains but two electrodes of this kind, and these are arranged in a rectangular ebonite box.

M. de Kabath, for his part, makes use of undulating strips analogous to those that we have described in Messrs. Pezzer & Carpentier's apparatus, but the undulations in this case being perpendicular and not oblique to the edges of the




SUGGESTIONS IN ARCHITECTURE.—ALTERNATIVE DESIGN FOR RECORD TOWER BY THE LATE G. E. STREET.

strip. In his apparatus, the wooden trough contains a certain number (say 6 or 14) of compound electrodes, which are placed at a short distance from each other. The plates of every other row, all connected with each other, are connected with a terminal which forms one of the poles of the pile; and those of the intervening rows, likewise united, are connected with the other pole. The arrangement, then, is similar to that of the plates of a Faure pile of rectangular model. At present, each electrode is formed of a hundred thin vertical strips, alternately plane and wavy, which, placed side by side, form a plate from 8 to 9 centimeters wide, by about 1 thick, and 40 in height. Upon the two wide surfaces of these plates are held the edges of the strips by means of leaden plates pierced with holes.

On another hand, Messrs. Sellon & Wolckmar have constructed accumulators with punctured leaden plates bent in various ways, but the principal point of their patent consists in the filling of the holes with spongy lead. The leaden plates used by these inventors are 4 millimeters in thickness, and the apertures are about 2 millimeters apart. The active part of the plate, then, is formed principally of the material that fills the apertures, the solid parts serving as a support, while, in a certain measure, participating in the electro-chemical action.

Finally, M. De Changy makes use of masses of lead, which are not spongy, but which are caused through his very mode of preparation to present a very great surface with a very slight weight. This result is obtained by melting lead and afterwards pouring it in a certain manner over a chilled surface. The lead thus suddenly cooled forms masses that are much divided. M. De Changy places these latter in a vessel divided into two compartments by a porous partition, and this is used as an electrode.

All these new arrangements have been employed as accumulators, and have been able to store up a certain quantity of electricity; but, up to the present time, no figures have been published in regard to the results, and it is, therefore, impossible to obtain any very definite judgment in regard to them. There is one point, however, that leads us to believe that they do not make the best utilization of lead for the accumulation of electricity. What the inventors have sought, in fact, is to give the lead a maximum surface for a minimum weight. That would be all very well were it a question of couples constructed like those of Planté, in which the entire surface is equally active; but, in the new accumulators, it is not altogether thus, for here we have indeed a very wide surface relative to the weight employed, but everything indicates that the different parts of it perform roles that are very unequally active. In the Faure pile, the inventor himself recognizes the fact that the action does not completely penetrate the mass of lead oxide. It must evidently be the same in such compound electrodes as reach the thickness of a centimeter. It is, moreover, a fact well known in electrolysis, that if we employ electrodes that are not plane the action is produced especially between their most approximate points.

In the compound plates that we have just described, action will take place, then, especially on the edge of the plates or strips composing the principal electrodes, and the central portion of the mass will remain but slightly active. We desire to say that in positive electrodes, for example, all the vertical strips will be well oxidized over their entire surface, but the oxidizing action will be much more energetic toward the edges than upon the middle portion of the strips; and, at this point, the lead will not be utilized as it should be.

This applies especially to the arrangement with horizontal or vertical strips, like those of M. De Méritens or of M. De Kabath. In Messrs. Sellon & Wolckmar's piles, in which the lead is 4 millimeters thick, the material that fills the apertures may be perfectly active throughout its entire mass, and we have seen specimens of electrodes in which it was so; but, in the solid parts of the plate, the penetration is not very deep, and there is there much poorly utilized lead.

As regards the practical applications of accumulators, a certain number have been made for the electric lighting of railways, and these we have noticed at the time. An endeavor has also been made several times to utilize accumulators as a portable source of electricity for the moving of vehicles by means of an electric motor. Of all the attempts made in this direction a single one appears to have succeeded, and this is the small electric railway installed by M. Clovis Dupuy at the bleaching works of M. Duchenne Fournet, at Breuil-en-Auge.* This railway, which is designed to take up the pieces of goods spread out upon the sward, consists in the first place of two cars, one of which contains ten hampers of Faure piles (Reynier model of 6 accumulators each), and the other an electric motor that can when desired put in motion either the wheels of the car or the roller which gathers in the goods. The wheels of the car may be locked by a brake, which, while performing this action, first weakens the current passing into the motor, and then, when the wheel is completely locked, intercepts the current completely. Behind this car are six open ones designed to receive the goods. The rails over which the train runs are laid perpendicular to the direction of the lines of goods, the latter being attached to each other end to end. It is only necessary, then, to fasten the first piece of goods to the reel and to set the latter in motion by the electric motor. From time to time the motor is geared with the wheels and the train is caused to run a few meters ahead.

The speed required, then, is small, but the train is capable, it appears, of making 12 kilometers per hour.

Now, if we consider the very great weight of the accumulators employed (the accumulator car weighs 800 kilogrammes), we see at once that there might have been made a better utilization of the electricity by a direct use of the rails as conductors, and as a source of electricity from the machine that is employed for charging the secondary piles. But special circumstances have prevented this being done; on the one hand, the dampness of the swards over which the rails are laid prevented the latter from being used as conductors; and, on another hand, the rails have a large number of switches, which would have complicated the installation. Steam power was likewise excluded through fear of the coal, smoke, and lighted cinders that might fall on to the goods, and so it was found most feasible to make the train carry its own source of electricity. We can only congratulate M. Dupuy for having undertaken this experiment; but it must not be forgotten that the advantages presented in this case by the use of accumulators so heavy as those employed are specially dependent upon the very peculiar conditions of the problem that had to be solved.

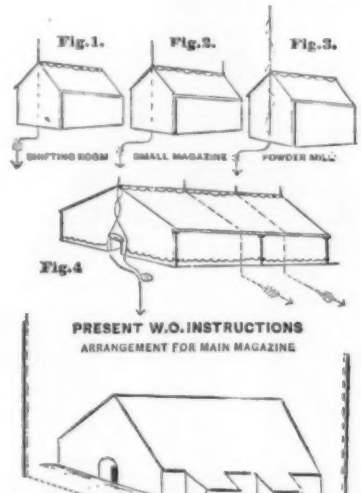
Accumulators will become really practical only after their weight has been considerably diminished, and, in our opinion, it will be necessary, in order to effect the latter, to look in another direction than that which seems at present to be generally followed.—*La Lumiere Electrique.*

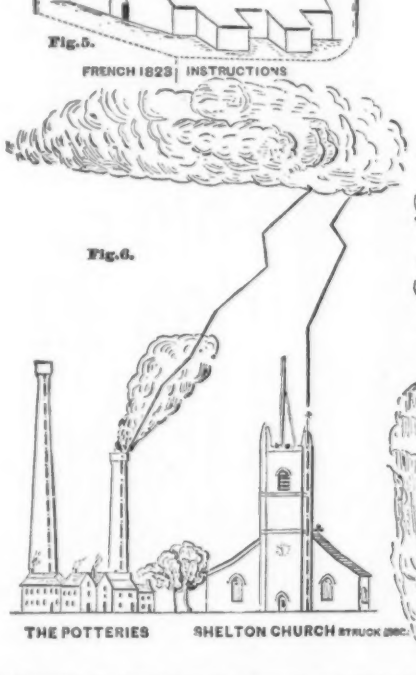
* See SUPPLEMENT No. 342, page 5447.

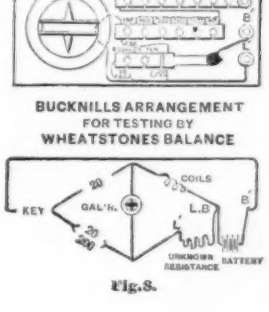
## ON THE PROTECTION OF BUILDINGS FROM LIGHTNING.*

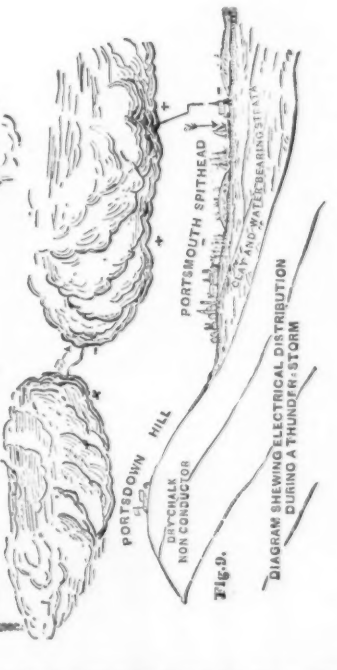
By CAPTAIN J. T. BUCKNILL, R.E.

A FEW weeks ago, when I accepted the invitation of the council of this institution to read a paper on the application of lightning conductors to buildings and magazines, it never occurred to me how difficult would be the task to deliver an *interesting* paper on so special a subject, or a paper that would be of value to a purely naval and military institution. It is, however, only too true that lightning strikes soldiers, sailors, and civilians alike, and that the laws which should govern the application of conductors are the same whether it be a palace or a jail, a chimney, a cathedral, or a man-of-war that has to be protected. Moreover, the immense interests jeopardized by any faulty arrangements, which might occasion the explosion of magazines, makes the subject of special importance to naval and military men. Imagine the loss to the war strength of the empire which would be entailed by the accidental explosion of one of the large magazines at Tipner or at Priddy's Hard, with its charge of, say, 750 tons of gunpowder, or over 750 millions of foot tons of energy developed in less than one second of time, and this within a short distance of the greatest naval arsenal in the world, and a town with 120,000 inhabitants.




Every building shed would be leveled to the ground, and the town would be visited as was Chios the other day. The proper application of lightning conductors to large magazines and to men-of-war is evidently therefore a matter of importance to us all.

Electricity exists in two distinct forms, the static and dynamic, but the word static thus applied is somewhat misleading, because electricity (like heat) is now recognized to be a form of matter in motion, whether in the state of potentiality as in a thunder cloud, or in the state of activity (the work-producing state) as in lightning.

How the former is produced is still conjectural, although a multitude of theories have been propounded.

In whatever manner the electricity is produced, the thunder clouds act as collectors; and more than this, when the surface of the earth beneath them is not far distant, and is composed of fairly good conducting media, the earth, the clouds, and the intervening air form huge condensers—the electrified clouds acting by induction upon the earth, and the latter reacting upon the cloud.

Now the amount or electricity of given potential which a cloud is capable of receiving depends first upon its size, the amount varying directly as the linear dimensions of the cloud; and secondly, upon the intensity of inductive action of the earth's surface, the cloud's power of receiving electricity being greatly increased thereby.

For example, a cloud of given dimensions at an altitude of 300 feet could be charged by 80 times the electricity that would charge it were its altitude increased to four sea miles.

For a similar reason a cloud over a conducting area could be charged much more highly than the same cloud at the same height over a non-conducting area.

One of the most remarkable of the phenomena connected with electricity is the mutual attraction of bodies charged with electricity of opposite sign, and the mutual repulsion of bodies charged with electricity of like sign. Now the charges on inducing and induced surfaces are always of opposite sign. The bodies possessing these surfaces consequently attract each other. If, therefore, thunder clouds be driven by the wind or otherwise over portions of the earth's surface which vary considerably in their conducting power, they will be attracted to those regions which from their conductivity present the greatest facilities for inductive action; and this, in spite of the mutual repulsion of the clouds; just as the numerous admirers of a beautiful woman, although hating each other, are attached to her.

Now it generally happens that the thunder clouds in a storm are sufficiently numerous to cover both favorable and unfavorable areas of the earth's surface, and, as little or no inductive action occurs over the latter, but very considerable action over the former, the electrostatic capacities of the clouds become greatly altered, and lightning plays from cloud to cloud, until those which are situated over the earth's conducting surfaces become so highly charged that the electricities are able to overcome the resistance of the intervening air and to unite across it by what is termed the disruptive discharge. This is lightning.

I have been thus particular in describing the action produced by the earth's surface upon thunder clouds, because the somewhat important conclusion must be arrived at, that lightning is most to be feared by those who live on well-conducted areas, even of low elevation; and that lightning is least to be feared by those who live on non-conducting areas. This is shown on plate, Fig. 9, where the distribution of the electrical charge is shaded in. The cloud over the Portsdown Hill, although nearer to the ground, is much less highly charged than the cloud over Portsmouth and Spithead, because the former presents a non-conducting area. This electrical distribution is of considerable importance, and it shows that it is much more necessary to provide lightning conductors for buildings situated upon a damp clay or boggy bottom than for those on a chalk down. This is very convenient, for it is almost impossible to make an efficient earth connection in the latter situation.

As before stated, disruptive discharge constitutes a lightning flash. Immediately before the stroke the particles of air are subjected to a high strain by static induction, producing a polar tension which is proportional to the square of the potential. Faraday's experiments proved this, as well as the fact that the stroke tends to traverse the air in the direction of such polarity. The tendency of lightning is therefore to strike in a direction normal to the earth's surface.

But there is another mode by which thunder clouds are discharged, viz., by the brush discharge.

Electricity of high potential leaks, as it were, from conductors which are provided with projections in the nature of points, where the distribution of electrical density is greatest, a stream of electrified air being thrown from each point, and the charged conductor robbed by continuous streams of electricity in this manner.

Although the brush discharge is frequently so intense as

* From the "Journal of the Royal United Service Institution."

to be luminous to a height of 6 or 8 inches, it is not attended with any appreciable heat. Its action should therefore be fostered, as it often wards off a dangerous stroke of lightning by neutralizing the opposing electricities in a harmless manner.

It has been observed so late ago as 1758 by a Mr. Wilcke, that a thunder cloud, in sweeping at low elevation over a forest, not unfrequently appears to lose charge without the occurrence of lightning. The under surfaces of such clouds at first present a serrated or tooth-like appearance, which gradually disappears, the teeth retreating into the cloud, and finally the cloud itself rising away from the forest.

In such cases the numerous points on the branches of the trees present facilities for the brush discharge on an extended scale.

To illustrate this action, an experiment was made by Franklin, as follows: A very fine lock of cotton was suspended from the conductor of an electric machine by a thread, and other locks were hung below it; on turning the machine the locks of cotton spread forth their fine filaments like the lower surface of the before-mentioned thunder cloud; on presenting a point which was connected to earth below them, they shrank back upon each other, and finally upon the conductor.

But to return to the lightning. Just as a certain amount of water falling through a difference of level produces a definite amount of energy, so a certain amount of electricity falling though a difference of electrical potential produces a definite amount of energy. It is known that if $p$ be the potential and $q$ the quantity of electricity in a flash, the work done during the stroke is $\frac{1}{2}qp$. Now the duration of the illumination of a stroke is rather less than the 10,000th part of a second, and although $q$ is small (Faraday said not more than would decompose a single drop of water), $p$ is so enormous that the flash is often capable of decomposing a million drops of water in series. The potential can be calculated approximately, because it is known that 10,000 volts will spark across a little more than half an inch at ordinary atmospheric pressure; and, as the sparking distance varies as the square of the potential, a flash of lightning 1,000 feet long must be impelled by an electrical potential of 1½ millions of volts or thereabouts. This is only approximately accurate, because the mean atmospheric pressure would be less than at the earth's surface, and therefore a correction should be made, as the pressure of the atmosphere decreases very rapidly with altitude, and the sparking distance increases very rapidly with decrease of atmospheric pressure. The work $\frac{1}{2}qp$ done by a flash of lightning is used in the disruption of the air, in the destruction of non-conducting solids that obstruct its path, in heat, in light, and in chemical decomposition. Ozone is always produced during thunderstorms.

All that can be done to protect buildings from its destructive action is (first) to attract the lightning to another spot if possible, and (second) to arrange that even if the building be struck, the work shall be given out at other portions of the path of the stroke. To do this it is necessary to provide a sufficient conducting channel or channels to convey the electricity past the buildings from the air to the ground.

First, let us examine the methods which have been pursued for attracting lightning away from the building which it may be desired to protect. The French Academie des Sciences has issued information concerning lightning conductors on different occasions, the several instructions having been the results of the labors of various commissions of celebrated physicists.

The first instruction, 1823, with Gay-Lussac as reporter, the rule is laid down that *a conductor will effectually protect a circular space whose radius is twice the height of the rod*, and it is stated to be in accordance with calculations made by M. Charles.

Accordingly we afterwards find in the same instructions that magazines should be protected in the manner shown on Fig. 5, the wording being: "The conductors should not be placed on the magazines, but on poles at from 6 to 8 feet distance. The terminal rods should be about 7 feet long, and the poles be of such a height that the rod may project from 15 to 20 feet above the top of the building. It is also advisable to have several conductors round each magazine."

In 1854, however, the next commission, with M. Pouillet as reporter, no longer supported this rule. The report says:

"At the end of the last century it was a generally accepted opinion that the circle protected by a conductor possessed a radius equal to twice the height of the point. The Instruction of 1829 (Gay-Lussac, *rapporteur*) having found that practice established, adopted it with certain reservations. . . . These rules . . . rest on much that is arbitrary, . . . and they cannot be laid down with any pretense to accuracy, since the extent of the area of protection in each case is dependent on a multitude of circumstances."

It is the more necessary to make this quotation, because an attempt has recently been made by Mr. Preece to revive the theory in a modified form. In a paper which he read before the British Association last year he attempted to prove that—

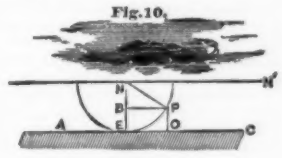
"*A lightning rod protects a conic space whose height is the length of the rod, whose base is a circle having its radius equal to the height of the rod, and whose side is the quadrant of a circle whose radius is equal to the height of the rod.*"

His argument was similar to, but not of such general application as, that used by M. Lacoine in a somewhat remarkable paper read 29th June, 1879, before the French Societe de Physique, from which the following is extracted:

"Experience shows that a thunderbolt has a tendency to fall on the metallic portions of a building. If then, by the assistance of a lightning conductor, we are enabled to protect a certain metallic surface, much more therefore will the same conductor protect the same surface if non-metallic.

"Let N, Fig. 10, represent a thunder cloud situated over the surface AC to be protected. Assume that the cloud is at such a distance from the point P of the lightning conductor PO, that the circle described from N as center with NP as radius will be tangential to the surface AC. Then the cloud will be equally attracted by the points P and E,* because these points are at the same potential, this rule having always been admitted in all the instructions of the Academie Française. Consequently every point on the surface AC within the circle with radius OE will be protected, but every point outside E towards A would be unprotected.

Fig. 10.




"Hence the radius of protection $r = \sqrt{NE^2 - NB^2}$, NE being the height of cloud above the ground, NB being the height of cloud above the conductor.

"It is enough, then, to know the height of the thunder cloud, to know the radius of action of a certain conductor.

"By several years' observation, and by direct measurement, the average height of thunder clouds could be obtained, and the mean value of $r$ for any given conductor deduced therefrom." *

Mr. Preece does not work out any such formula, but bases his rule on an assumption that a thunder cloud would never be nearer to the earth than the height of the lightning rod. This is open to question, as very low-lying thunder clouds may be driven by the wind into the neighborhood of lofty conductors that command the clouds; and this is corroborated by a case recorded in Mr. Anderson's excellent book on lightning conductors, page 67, where the belfry of an edifice, 115 feet high, "remained standing out clear above the electric cloud" whence issued lightning that killed two priests near the altar of the church. As a single application Mr. Preece's rule comes at once from M. Lacoine's formula.

It is perhaps important to bear in mind these theories concerning the area of protection given by conductors, when it is necessary to fix a few conductors on buildings of considerable extent, such as barracks, hospitals, etc., but sufficient reliance cannot be placed upon the rule to enable us to consider the protection to magazines, as shown on Fig. 1, and already alluded to, as efficient.

The area of protection afforded by a conductor depends much more upon the efficiency of the earth connections than upon the height of the terminal point, and in proof thereof many instances might be cited. For example, in the case of Shelton Church, in the Potteries, which was struck on June 10, 1880, the tower, about sixteen feet square, is surrounded by four pinnacles sixteen feet above the roof, which is nearly flat and covered with slates, with lead guttering and ridges. From the center of the roof springs a large flagstaff, about forty feet high (see Fig. 6), secured to the tower in the upper chamber twenty feet below the roof by large cross beams unconnected, except by stone work, with the clock-works, bells, and gas pipes in the chambers of the tower. A copper wire rope five-eighths of an inch in diameter is fitted to one pinnacle and taken direct to earth. Although the flagstaff projects some twenty feet above the conductor, and is distant only ten feet, a very heavy stroke of lightning, which caused much alarm, and which was seen to fall upon the tower, struck the conductor, knocked the point slightly out of the perpendicular, and passed off by it innocuously. In this case a good conductor, well connected to earth, protected something higher than itself, but not well connected to earth.

Again, Sir William Snow Harris mentions a chimney at Devonport which, although provided with a conductor, was struck on the other side, and shattered down to the level of a metal roof below. Here the conductor must have been badly connected to earth, and was useless.

Moreover, the safe area rule may be upset in practice by all sorts of accidental circumstances. Thus, a house within the theoretical circle of protection given by a church spire close at hand might be struck if the line of least resistance from cloud to earth were afforded by a column of rising smoke from the kitchen fire, and the shorter of the two chimneys in Fig. 6 would most assuredly be struck, for a similar reason, although it is within the theoretical cone of safety of the taller chimney as fixed by Mr. Preece.

In short, if thorough protection be desired for any building, it is necessary to put a conductor or conductors upon it.†

Let us now examine the manner in which conductors should be applied.

Churches and dwelling-houses of ordinary dimensions, factory chimneys, monumental columns, etc., need but one conductor led from the most lofty point to the ground, to which a thorough efficient earth connection (to be described presently) must be given. As a rule, it is the best plan to fix the conductor externally, in which case it should be connected to all *external* metal surfaces, but *not* to any masses of metal wholly within the building. It should be fixed to the exterior by strong clamps of iron or other metal, and provision should be made for its expansion and contraction due to differences in temperature. It should be continuous from top to toe. It should possess a proper amount of conducting power per unit of length.

As regards the last-mentioned and most important matter of conductivity, the last French instructions, dated February 14, 1867, state that there is no case on record where lightning has fused a square bar of iron having a side of 0·6 inch, or a section of 0·36 []"—and square iron conductors 0·8 inch side are recommended, which gives a section of 0·64 []". Also, Sir Willliam Thomson considers that a round iron bar 1" diameter would form a very safe protection for magazines; this would be about 0·77 []" sectional area. It would appear that continuous iron conductors weighing 6 lbs. per yard would be quite safe, as shown in the following table:

TABLE A.

| | Iron conductors. | | |
|---|---|---|---|
| | Side. | []" | Lb. per yd. |
| Limits of safety—French instruction | [] 0·6" | 0·36 | 3·6 |
| Conductors recommended by ditto— | | | |
| from | [] 0·75" | 0·56 | 5·6 |
| to | [] 0·8" | 0·64 | 6·4 |
| Sir William Thomson recommended | O 1·0" | 0·77 | 7·7 |
| New W. O. instructions | .. | 0·8 | 8·0 |
| Now proposed for general purposes | .. | 0·6 | 6·0 |

Now iron has about one-seventh, and good commercial copper about four-fifths, of the conductivity of *pure* copper. Hence iron has about one-sixth conductivity of good commercial copper. A safe conductor in good copper must therefore weigh one pound per yard.

It is, however, inconvenient to specify for a conductor either by sectional area or by weight per yard, because different samples of metal, and especially of copper, vary considerably in their conducting power. See table.

Table of conducting power of different descriptions of copper:

TABLE B.

| | |
|---|---|
| Pure copper | 100 |
| Lake Superior | 98·8 |
| Commercial | 92·6 |
| Burra Burra | 88·7 |
| Best selected | 81·3 |
| Bright wire | 72·2 |
| Tough | 71·0 |
| Demidoff | 59·3 |
| Rio Tinto | 14·2 |

Temp. about 15° C. or 60° F.

Imagine a conductor made of Rio Tinto copper! No doubt many exist.

A limit of electrical resistance per unit of length should therefore figure in any contract for a lightning conductor, and for the conductors already recommended this limit would be 0·3 ohm per 1,000 yards, or 0·03 ohm per 100 yards, at 60° Fahrenheit or 15° C.

This would be obtained from iron wire rigging ropes weighing 6 lb. per yard, or from copper (equal to 80 per cent. pure in conductivity) ropes weighing one lb. per yard.

When two "earths" are used, and the conductor is carried up one side and along the ridge and down the other side of the building to be protected, it is evident that the conductor may be reduced in power by one-half, but no further reduction can be made when a still greater number of "earths" are used, because the lightning may strike the system of conductors at any point. A 3-lb. iron (or a half-pound copper) rope is therefore the smallest that should ever be used in any situation.

There is much difference of opinion as to whether iron or copper is the better material for lightning conductors.

The French use iron almost exclusively, and Sir W. Thomson prefers it to copper.

For the same money the same conductivity can be purchased in either metal (iron being one-sixth of the price and one-sixth of the conductivity of copper), and iron has the following advantages:

(*a.*) The mass of an iron conductor being greater than that of a copper conductor of equal conductivity, it is heated less by a given current of electricity.

(*b.*) The fusing point of iron (2,786° F.) is much higher than that of copper (1,994° F.).

(*c.*) Iron is more constant in its conductory power than copper of different samples.

(*d.*) A conductor made of iron is not so liable to be stolen as copper, and being so much stronger is therefore less liable to be broken, accidentally or otherwise.

(*e.*) A copper conductor if connected to a cast-iron water supply pipe (to form an "earth") produces galvanic action, to the damage of the pipe.

On the other hand, a copper conductor lasts longer in smoky towns or near the seashore, where the air rusts iron quickly, and being of much smaller size it does not interfere so much with architectural effects. But Sir W. Thomson has suggested that iron conductors should be treated boldly by architects, and brought into prominence purposely and artistically, and the late Professor Clerk Maxwell recommended that in the case of new buildings the conductors should be built into the walls. They would then not only be hidden but protected from the weather, from the British workman carrying out repairs, and from the thief.

As regards the liability of iron to rust, galvanizing is in most situations a sufficient protection, and in smoky towns an iron conductor should be painted periodically.

On the whole, therefore, the advantages of iron outweigh those of copper so considerably, that the employment of copper in lightning conductors should be the exception instead of the rule.

Those who make, supply, and apply lightning conductors in this country, nevertheless, invariably recommend copper; and it is quite difficult to convince them to the contrary.

Another point I notice is that large conductors are always recommended for lofty buildings, and smaller conductors for smaller buildings, and the same for masts of ships. This is unscientific and wrong. The stroke of lightning falling on a short conductor is no less powerful than the stroke that falls on a lofty conductor; indeed, the chances are in favor of the shortest conductors receiving the heaviest strokes, if they are struck at all. On costly and important buildings, the proper course to pursue is to increase the number of conductors, and of the earth connections, the limit of electrical resistance between any possible striking point and earth being kept below what is fixed upon as the point of safety, viz., 0·3 ohm per 1,000 yards.

We will now examine the question as to the best *form* of conductor. Mr. Preece has investigated this subject, and by permission of Dr. Warren De la Rue, carried out in that

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* This is open to doubt; the electrical charge on the cloud is attracted by the induction of an opposing *surface*, the total attraction being proportional to the sum of the tubes of force existing between the two opposing surfaces, charged by inductive action. To assume that the charge on a thunder cloud is concentrated at a single point is not in accordance with the circumstances of the case in nature.

Faraday's experiments have conclusively proved that static induction polarizes the particles or molecules of the interposing dielectric, and that dynamic currents tend to traverse the same by disruptive discharge in the direction of the said polarity.

Assuming therefore that a lightning flash from the charged surface NN' occur at N, it will have a tendency the follow the direction NE rather than the alternative route NP, because polarity exists between NE to a greater extent than between NP.

This consideration will cause the theoretical circle of protection advocated by M. Lacoine to be considerably diminished when the charged cloud lies low, but when the cloud is at a considerable altitude NP becomes more nearly normal to the surface AC, and more nearly parallel to the direction of polarity of the atmospheric particles.

* As the height of thunder clouds varies enormously, the values for $r$ would range between proportionately wide limits, and the *mean* value of $r$ obtained by M. Lacoine would seem to possess no definite or practical utility. If, however, the observations were directed to observing the minimum altitudes of thunder clouds in each locality (the altitudes will be found to vary with the locality), the smallest areas of protection given to conductors there situated could be approximately established.

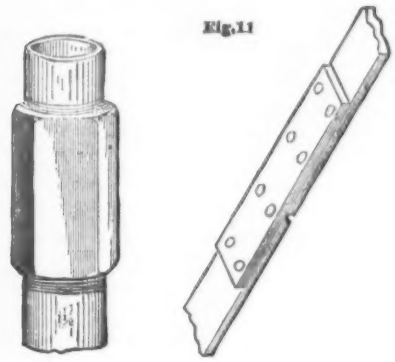
† A lamentable result of the practice of placing lightning conductors distant from a building occurred at Compton Lodge, in Jamaica, the residence of J. Senior, Esq. A lightning rod, of small dimensions, of iron had been set up within ten feet of the southeast angle of the building, as used to be the practice with gunpowder magazines, on the assumption that the rod would attract the lightning and secure the building. So far from this, the building itself was struck in a heavy thunder storm July 28, 1857. The southeast angle was shattered in pieces; the escape of the family appears to have been miraculous; while the lightning rod, ten feet distant, remained untouched. If this building had been a deposit of gunpowder, it would certainly have blown up.

Sir Wm. Snow Harris said: "To detach or insulate the conductors is to run away from our one principle, which is, that the conductor is the channel of communication with the ground, in which the electrical discharge will move in *preference to any other course*. To detach or insulate the conductor is to provide for a contingency at once subversive of our principle. Is it possible to conceive that an agency which can rend rocks and trees, break down perhaps a mile of dense air, and lay the mast of a ship weighing eighteen tons in ruins, is to be arrested in its course by a ring of glass or pitch, an inch thick or less, supposing its course were from any cause determined in that direction?"

gentleman's splendid laboratory a series of experiments on the best sectional form for lightning conductors. The results were communicated to the British Association at Swansea last year. He found that ribbons, rods and tubes, of the same weight per foot, were equally efficient.

The application of rods and tubes necessitates frequent joints, generally made by means of screw collars. I have found by electrical tests that these joints after long exposure to weather offer very high resistances; especially so in copper conductors. For instance, at Tipner magazine, a screwed joint in a large tubular copper conductor tested 10,000 ohms, and a riveted joint in a ribbon conductor on a battery in the Isle of Wight 700 ohms. These joints could not be moved by hand, and were apparently quite tight.

Fig.11



Ribbons of *copper* are now made in long continuous pieces (as much as 70 or 80 feet in one length), and can be applied to irregular architectural outlines, but the joints, although less frequent than with rods and tubes, are open to the same objections. The copper ribbon, however, possesses one decided advantage, viz., that by the introduction of suitable bends, the expansion and contraction from heat and cold can be allowed for. Iron conductors, when in the form of tubes, rods, or ribbons, are difficult to apply, and must possess a number of joints. Moreover, in long conductors, compensators to allow for expansion and contraction by heat and cold have to be introduced. In order, therefore, to obtain with iron the necessary continuity and pliability, it is best to resort to the wire rope, which form is already very generally employed for copper conductors. Pliability can be obtained in several ways:

1. By using small wires.
2. By making the rope *flat*.
3. By using a hemp core with the round rope.

It is not advisable to make the iron wire ropes with very small wires, because oxidation destroys such a rope rapidly if through carelessness the conductor be left unpainted. A fair amount of pliability can be obtained with a round iron rope 6 lb. per yard if the wires are about No. 11 B.W. gauge, and arranged in six strands of seven wires each round a hemp core, thus producing a rope about 3¾ inches in circumference.

But there are few situations in which two ropes of half the size could not be more readily applied; and I think the double rope, if taken up on one side of a tower and down on the other, in one continuous length, has many advantages.

When a single conductor is desired, the best for general purposes is probably a flat-iron wire rope about 2¼″×⅛″ (11 lb. per fathom), or 2½″×⅛″ (13 lb. per fathom). The round ropes cost from 21s. to 24s. a cwt., or about 2s. 6d. per fathom for a 12-lb. rope; and the flat ropes 33 per cent. more, or add one-third.

The next question that presents itself is concerning the terminal point, and a good deal of nonsense has been written about it. Points made of silver or of copper, points covered with platinum or with gold, points of so many millimeters in height and diameter, and possessing certain exact forms, have been proposed, and rejected or adopted as the case may be.

The height of the points above the surrounding roof or tower to be protected has also been much debated with very little profit, for to this day many of the rods erected on the Continent are made much longer than is necessary.

It is a good plan to carry conductors on lofty rods high above powder mills, flour mills, and petroleum oil wells; but these are exceptional cases, the air close to these buildings being frequently charged so as to be dangerously explosive.

The English practice of using a short rod in most situations is a reasonable plan, the rod being placed on the highest part of the building. The rod should be made of the same metal as the conductor, and the connection formed with bolts and afterwards run in with molten zinc or solder. The weight of the rod per foot should be the same as the conductor. The top of each rod should be provided with several points, (*a*) because the gathering power is increased thereby, and the chance of lightning striking other things in the immediate vicinity of the conductor is proportionately diminished; (*b*) because the top of the rod is less likely to be fused when struck, the stroke being divided between the various points; and finally (*c*) because the brush discharge is facilitated.*

Another plan is to carry the wire rope up the side of the rod, which in this case might have one point, the wires being opened out to form a brush-like arrangement just under the point. The wire rope and the rod should be bound together with wire and connected with molten zinc.

We must now pass to the foot of the conductor, and here we enter upon the most difficult part of our subject. The earth connections of a lightning conductor constitute the most important portion of the whole arrangement. If the electrical resistance of the earth connections be high, a conductor, perfect in all other respects, may fail, some alternative and perhaps dangerous route being taken by the lightning discharge. It is difficult to fix the limit of maximum resistance of the earth connections.

The Academie des Sciences recommends an iron earth plate, consisting of four arms on a central bar, or five arms in all, each 2 feet long and of square section 0·8 inch side, thus presenting a combined surface of 2·6 square feet, to be immersed in water in a well that never dries.

* Sir William Thomson's opinion: "A fork or brush of three or four points at the top of a lightning rod is probably in general preferable to a single point; but of what practical value this preference may be I cannot tell for certain, although I think it may be considerable."

Again, Mr. Anderson, in his book before referred to, says that—

"When a conductor is taken deep enough into the ground to reach permanent moisture, the single rope touching it will be quite sufficient. But when the permanency of the moisture is doubtful, it will certainly be advisable to spread out the rope like the fibers in the root of a tree."

Here a few square inches touching permanent moisture is considered sufficient.

Again, Professor Melsens used three earths for the Hotel de Ville at Brussels—one the gas main, another the water main, and the third a cast-iron pipe, nearly 2 feet diameter, sunk in a well and giving 700 square feet of surface to the water, which was rendered alkaline with lime to prevent oxidation. The total surface of these three earth connections amounts to more than 2½ million square feet!

As opinions differ so greatly concerning the surface required for the earth connections, it will be necessary, before laying down any rule, to give some of the reasons upon which it is based.

I must ask you to examine Table C, of Resistances, which has been compiled from various authorities, and which deals with such enormous differences that it can only be regarded as approximately accurate:

TABLE C.—*Of Resistances.*

| SUBSTANCE. | Comparative Resistances in Ohms. | | Effective Section. |
|---|---|---|---|
| | Copper unity. | Iron unity | |
| | | | Sq. in. |
| Pure copper | 1·0 | ..... | ..... |
| Commercial copper | 1·17 | 0·2 | 0·2 |
| Iron wire | 7·0 | 1·0 | 1 |
| | | | Sq. ft. |
| Carbon | 2,500 | 360 | 2½ |
| Coke, variable with the sample, about | 3,000 | 400 | 3 |
| | 4,000 | 600 | 4 |
| Sat. sol. sulph. zinc | 6,000,000 | ..... | ..... |
| Salt (sea) water | 10,000,000 | ..... | 10,000 |
| Approximately only | 15,000,000 | ..... | 15,000 |
| Water (spring) | 2,800,000,000 | ..... | 2,800,000 |
| " distilled | 6,754,000,000 | ..... | ..... |
| Dry earth (practically) | Infinity. | ..... | ..... |

We might state the figures against water in this table thus:

The electrical resistance offered by a cylinder of spring water one yard long is as great as the resistance offered by a cylinder of copper of equal diameter, but seven times longer than the distance of the moon.

The study of this table involves some rather curious considerations. Let us call 1 square inch of iron its efficient section* or conductive capability for carrying off a stroke of lightning. Then the efficient actions of carbon, of water, etc., are as shown in col. 4 of table.

Now the practice in the War Department has always been to give joints in conductors a surface of about six times the sectional area of the conductor. This is a very good rule, and is borne out by the French practice, where even with soldered joints, 6 square inches of surface is laid down as necessary at each joint in an iron conductor. An obvious corollary to this rule is, that when a conductor is made of two metals (end to end) the joint must have a surface equal to six times the efficient section of that conductor of the two joined which possesses the lowest conductivity. The efficient section of the better conductor ought not in any way to govern the amount of surface of the joint. Thus copper to iron requires a joint of six square inches, the same as would be required by iron to iron. In short, the joints should be made of such a size as to prevent the conductors of lower conductivity being damaged by the lightning.

A copper to copper joint only requires 1 square inch of surface, but it is generally convenient to give more.

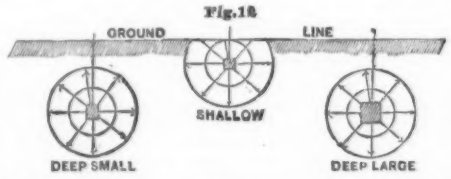
Now, the earth connection is really a joint—a very difficult joint to make well, and one that should follow the rules of other joints, *unless we can show good reason to the contrary.*

It is found that increasing the size of an earth plate does not proportionately decrease the electrical resistance. A limit of size is soon arrived at, beyond which it is useless to go. "In the sea this limit is quickly reached."—(Culley.)

Culley states that if a plate containing 1 square foot of surface gives a resistance of 174 ohms, a plate of 4 square feet will give 140 ohms, and so on, a reduction of only 20 per cent. in resistance being obtained by quadrupling the earth plate surface.

The explanation that suggests itself as probable is that the electric current is distributed through the humid ground by an ever-increasing sectional area (often by a hemispherical surface), thus arriving at the efficient section for a water conductor of two millions of square feet (see Table C), at the small distance of 200 yards, or thereabouts,† from the earth plate; and this is borne out by the fact noted by Culley, that the resistance depends to a certain extent upon the depth at which the plate is buried. Thus, a deep plate would disperse its charge in all directions by an ever-increasing spherical surface up to the limit of a sphere whose radius is equal to the depth of the plate underground, and afterward by a segment of an ever-increasing sphere, which segment would always in this case be larger than, but would gradually approximate, the atmosphere. These actions are roughly shown on Fig. 12:

Fig.12




Culley states that the resistance alters with the depth at which the earth plate is buried as follows:

| | | |
|---|---|---|
| 4 | inches. | 100 ohms. |
| 10 | " | 90 " |
| 40 | " | 80 " |
| 80 | " | 77 " |

* This has already been shown to be rather less than a square inch of solid iron.

† In an arid plain with a dry subsoil, the surface of which was wet by rain only to the depth of one inch, the efficient section of water conductor would not be reached at a less distance than fifty miles.

It would appear, therefore, that little is to be gained by increasing the surface of junction between the earth plate and the earth (1) beyond the amount required to insure that the resistance to earth at foot of conductor is less than the resistance to earth through possible alternative routes in the vicinity of the conductor, and (2) beyond the amount required to prevent damage to the conductor by the flash of lightning when it leaves for earth. It is evidently impracticable to give a surface of some millions of square feet to the earth connections, and if it were practicable, the foregoing considerations prove, I think, that it is not necessary to do so.

The difference in the conductivity of iron and water is so enormous that an intermediary appears to be very desirable. Carbon is eminently suited to act in this manner, especially if used in the cheap form of coke and ashes. The minimum effective section for coke is about 4 square feet: the iron which is surrounded by coke should, therefore, have a surface of 24 square feet. Moreover, inasmuch as the contact between an iron plate, of whatever form, and coke loosely surrounding it, must frequently be discontinuous, and as the conductivity of coke in a mass composed of loose particles must be very much lower than that of a solid piece, the above surface should in practice be a minimum.

The total surface may, however, be divided if a number of earths be used.

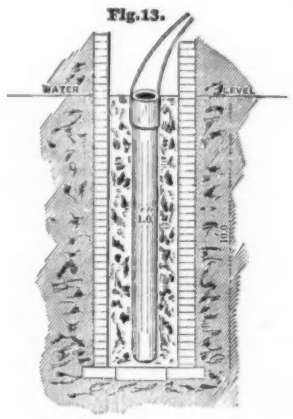
The outer surface which should be given to coke must depend very much upon the nature of the ground; when the conductor is led into soil which cannot be regarded as permanently damp, the surface of the carbon "earths" must be increased.

As the surfaces of the earth connection should vary directly as the resistance per unit of area, an intermediary of coke becomes unnecessary where a conductor is led into salt water; but the conductor should still present a total surface to earth of from 20 to 30 square feet, the amount being divided between the "earths" if several conductors be connected.

Professor Pouillet's Committee, which reported upon the application of conductors to the Louvre in 1854–55 (the said report being adopted by the Academie des Sciences), recommended that when permanent water is not found near the surface two descriptions of "earth" are necessary: first, the deep earth connections to permanent water, and secondly, the shallow earth connection to the surface water. This for the following reasons: After a long drought, the "terminating plane of action" (to use Sir William Snow Harris's term) is situated on the upper surface of the deep water bearing strata, the induced charge being consequently collected there. After a heavy rain, however, which thoroughly impregnates the upper strata with water, the "terminating plane of action" is raised to the surface of the ground, and the induced charge is accordingly collected there. It is evident, therefore, that a perfect arrangement should in many situations provide both for *surface earths* and for *deep earths*. In some situations, however, such as the top of a chalk hill, deep earths would be of little value; whereas in other situations surface earths would be inefficient—in a well-paved town for instance, where the surface water is at once carried off by gutters and drains.

A deep earth connection can be effected in the manner shown in Fig. 13, the well being carried down 10 feet below

Fig.13.




water level in the driest seasons. The diameter of the well may be fixed at 3 feet. It should be rendered alkaline with lime, so as to protect the iron from rust.

The bottom 10 feet should have no mortar or cement in the walls, and should be filled in with blocks of coke. The iron conductors should terminate in cast-iron pipes, offering together 24 square feet of outside surface. The pipe should be galvanized to preserve it from oxidation. The dimensions of the pipe may be, length 10 feet, diameter 1 foot. The pipe may rest on the bottom of the well, in a vertical position. The best way to connect the pipe with the conductor is to have a flange at the top (all ordinary gas or water pipes have such flanges), and to rivet a small cylinder to the inside of the pipe at the upper end, thus forming a ring or annulus, into which the end of the conductor can be introduced, and the space filled in with molten zinc, the surfaces of the conductor and of the pipe having first been cleaned and painted with hydrochloric acid.

In situations where iron water supply pipes are at hand, they can be employed in place of the deep earth connections already described, but great care must be devoted to the connections. The conductor must be laid along the iron pipe for a distance of 4 feet (if an iron wire rope it should be unlaid for this distance), it must then be bound to the pipe with wire, and a metallic connection formed by means of lead, zinc, or solder. The connection should then be tarred and covered with tarred tape to prevent galvanic action.

Surface "earths" should consist of a trench filled with coke and ashes, and carried away from the walls. Clay and other soils which keep the rain-water near to the surface require shallow trenches about 1 foot deep; whereas gravel, sand, or shingle, through which the water penetrates easily, require deeper trenches, say 2 feet deep.

In each case, however, the top surface should be kept on the ground level.

The end of the metal conductor should be carried along the bottom and through the whole length of each trench. This length may in ordinary soils be fixed at 25 feet, and in very porous soils at 50 feet.

The water pipes from the roof of the magazine or building may with advantage be caused to deliver into gutters which lead to the surface "earth" trenches.

The shallow trenches, 1 foot deep, recommended for stiff soils, may conveniently be split into a V shape on plan (the conductor being split also), so that the total side surface may be equal to that given by the same length of deeper trench used with porous soils.

Important buildings and magazines provided with several conductors may have a few deep "earths," and several shallow "earths," an "earth" of one or the other description being provided at the foot of each vertical conductor, and in order to connect the whole it is advisable to employ a horizontal conductor near the foot of the wall, but above ground in order that it may be open to inspection, such conductor being carefully connected to all the vertical conductors, and to all the metal water-pipes. By this means not only is the cage principle advocated by the late Professor Clerk Maxwell and other physicists embodied, but the earth connections are connected in an efficient and reliable manner.

Sir W. Thomson considers that conductors on magazines should be spaced at intervals of about 50 feet, by which plan no portion of the building would be more than 35 feet from a conductor. This rule has been adopted by the War Department for all large magazines, and a conductor of power equal to an iron rod weighing 8 lb. per yard has been adopted for single conductors, and of half that weight for all others. A wire rope of 4 lb. per yard applied *as shown in diagram*, is now considered the best arrangement.

It will be seen that wherever the lightning falls a conductivity equal to, or more than, that of a single large conductor will carry the stroke off to earth.

Small magazines can be protected by one rope led to a deep "earth" at one end and to shallow "earth" at the other, as shown on diagram.

Powder mills must be provided with lofty conductors, to guard as much as possible against powder dust in the air being ignited by the stroke.

As regards the inspection of lightning conductors opinions vary greatly, and it was mainly in order to obtain a report on this matter that I was ordered last summer to inspect a number of conductors on magazines in the Portsmouth district. I will read a few extracts from my report. (See Appendix I.)

Before concluding this paper, I may observe that the principal object has been to prove the following points:

1. That iron is the best metal to use in conductors.
2. That wire ropes are more easily applied than rods, ribbons, tubes, &c.
3. That conductors should be continuous, and that all unavoidable joints should be soldered.
4. That conductors should be specified in terms of electrical units.
5. That lofty conductors require no additional conductivity per unit of length.
6. That high lightning rods are only required in exceptional situations.
7. That several points are preferable to a single point.
8. That greater surface than is usual with present practice should be given to earth connections.
9. That both deep and shallow earths are required.
10. That periodical inspection is most important.
11. That the history of conductors and of former tests should be carefully recorded.
12. That electrical tests may then be of value.

### APPENDIX I.

I have to report that, in accordance with instructions, I have made nearly 500 tests, and have inspected the whole of the lightning conductors on fortifications in the Portsmouth and Gosport Divisions of the southern district, and have come to the deliberate conclusion, after a careful study of the subject, that *with the lightning conductors erected as they are at present by W. D.*, electric testing is of small value.

The fact that the conductors on one building test lower than the conductors on another building certainly points to the inference that the earth connections in the former case are of superior efficiency; but it does not prove it. Moreover, although the tests are sometimes of value to the inspector *when he knows the details of the earth connections from the office records*, the tests taken by themselves are frequently positively misleading, so far as the earth connections are concerned. As regards the conductors themselves, above ground, high resistance tests do not prove inefficiency when the W. O. rule that the surface of the joint shall be at least six times the sectional area of the conductor is strictly adhered to; and in this view I am borne out by Sir William Thomson's opinion, which now lies before me, viz., "that although it would be desirable that the joints should be considered and run in with lead, so as to make sure of absolute contact, at the same time it is to be remarked that the great resistance at imperfect joints is not detrimental to the lightning conductor, because, when a discharge takes place, the imperfect joint is bridged across, and the resistance, which is very great when tested by a feeble current, becomes practically annulled in the electric arc during discharge.

Dr. De la Rue also writes to me and says: "The resistance of many megohms would offer an insignificant obstacle to a lightning discharge, on account of the extremely high potential of a thunder cloud. Consequently, a conductor would be quite efficient, although offering a megohm resistance."

The opinion that lightning conductors with large surface joints are efficient, although offering high resistance at the joints, is also substantiated by the well known action of plate paratonnères, as applied on the flanks of electric telegraph stations, to protect the instruments therein from the effects of strokes of lightning upon any portion of the line. These paratonnères consist of plates, in most patterns smaller than the flat joints of lightning conductors, and paraffined paper is interposed between the plates the more thoroughly to insulate the lower plate from "line." A number of these paratonneres are in store at Woolwich, and they each test from 3 to 40 megohms of resistance; yet in practice a flash of lightning is always found to pass across them to good "earth," in preference to the alternative path offered through the telegraph instrument, usually of less than 2,000 ohms. It is therefore quite erroneous to suppose that lightning always passes to earth by those paths which, *to ordinary voltaic current*, test lowest. It, however, does pass to earth by those paths which, *to a current of its own potential*, would test lowest. . . .

With regard to the conductors now existing on our magazines and fortifications, and which have been erected for the most part on sound principles, and which have never yet failed, it would appear that the periodical inspection should be performed by a thoroughly competent inspector who has studied the subject. He should be provided with drawings and record plans, and every information that can be afforded of each and every conductor in the district to be inspected. The information concerning the earth connections should be most minute and exact. He should also be provided with a light equipment for making such electrical tests as he may find necessary. If this were done, my recent experience would point to the conclusion that the electrical tests would form the least important portions of his periodical reports. . . .

As far as my own experience has gone, it would seem that our conductors are, with few exceptions, as efficient now as when they were first put up; but the earth connections of most of the conductors are and always were considerably below the standard. . . .

Although the lightning conductors at present on our magazines and forts are, no doubt, so far as the conductors themselves are concerned, efficient, their efficiency could nevertheless be guaranteed with greater certainty if more modern practice were followed. . . .

The adoption of modern practice would at once make electrical testing of considerable value, because with *unbroken continuity* and the *best earth connection*, all conductors would test at a very low figure indeed, unless out of order. An economy would also be effected on all new works, because metal pipes and rods, with costly sliding joints to allow for expansion and contraction, would no longer be required.

As regards the testing of conductors, a few tests were taken with the three-coil galvanometer, but with no satisfactory results, as the instrument is not sufficiently accurate when used as a measurer of electrical resistance. An attempt was then made to test by means of the "earth" cells produced by the earth of the lightning conductor, which was always either of copper or iron and a test earth of iron or copper. This gave promise at first of becoming a good test, the astatic galvanometer being employed, but the method was soon discarded from want of accuracy. It is, however, useful for the tester sometimes to discover the metal of the earth connection of a conductor, and the above method can then be resorted to. . . .

A quarter mile of the light insulated wire for engineer mountain equipment (60 lb. per mile) was cut up into three pieces, each 110 yards long and 4 ohms resistance, and two pieces each 55 yards long and 2 ohms resistance. This wire was found to answer well, and being so light, could be carried over a man's shoulder without any difficulty for considerable distances. . . .

Two small plates (one copper and one iron) were used, their dimensions being 7 inches wide and 8¼ inches long; they were of oval shape, and made of quite thin metal. A lip was formed at the top, and a hole punched in the plate 2 inches below it; a 2-foot piece of Navy demolition cable was then brought through the lip, passed through the hole, the wires cleared of insulation for 1½ inches, and the ends spread out like a fan and soldered to the plate. The lip at the top was then firmly hammered over the covered wire until it held the wire tightly. The other end of the piece of core was then stripped and the wires sweated together ready for insertion into a brass connector when required.

A number of resistance tests having been taken with the P. O. pattern resistance coils, an astatic, and service six-cell test battery, it was found that the tests usually ranged below 200 ohms; and I designed an instrument to test these resistances with approximate accuracy up to 200 ohms, and to measure roughly up to 2,000 ohms, the bottom plug being placed in the "×TEN" hole, when measuring the higher resistances. The whole arrangement weighs less than 6 lb. when the battery is charged: its dimensions, moreover, are only 9"x5¼"x6" over all, and the method of using it can be taught to any intelligent man in a few minutes. The instrument shown on Fig. 7 is the latest and improved pattern, and has a range up to 1,110 ohms, when testing direct by steps of 1 ohm; and to 11,100 ohms by steps of 10 ohms, when using the multiplying hole marked "×TEN." In testing a conductor's "earth" the wire to the conductor would be taken to terminal L'; one pole to the battery and the wire to the test earth plate to terminal BL, and the other pole of the battery to terminal B'; the plugs on the upper row of brasses would then be moved about until no deflection is produced upon the galvanoscope on the battery key being pressed down, the bottom plug being placed in the "EQUAL" hole. If, however, the resistance to be found is more than 1,110 (shown by above trial) the bottom plug is moved to the "×TEN" hole, and a balance obtained and recorded.

The silver chloride battery is used on account of its small weight, and when kept in a dark box it is fairly permanent. All the connections are permanently made, which simplifies the testing very much indeed. These connections are all shown in the diagram, and will be understood by any electrician. The sketch on Fig. 8 shows the electrical arrangement a little more graphically. Everything is done permanently, except the connection of the unknown resistance *x* between terminals L' and BL, the plugging at R, and the insertion of the EQUAL or ×TEN plug. The tests taken in the Isle of Wight were performed with the instrument. It saved much time, being very rapid in action and easily set up. It has also been checked for accuracy by a series of tests at Woolwich with satisfactory results.

A special clamp was found to be useful in connecting the test wire to the conductors, a small clean spot being produced by a file for the end of the screw to seat upon. When the leads had to be connected for long stretches the naval pattern brass connectors were used.

### APPENDIX II.

*Extracts from a Memorandum by Colonel H. Schaw, R.E., 1879, on Lightning Conductors.*

The testing of the electrical resistance of a system of lightning conductors will generally present great difficulties, because the ordinary means of allowing for expansion and contraction by slotted joints destroys the metallic continuity of the conductors, and introduces a variable resistance of oxides and foreign substances between the slipping surfaces.

This resistance will generally be very much in excess of that of the whole length of the conductors; it is, however, of little or no consequence when opposed to electromotive force of such high tension as a lightning discharge, which will easily pass the obstruction, as exemplified in the form of lightning protector used by Messrs. Siemens for electric telegraph stations, which is formed by two brass plates with roughened surfaces placed face to face, but prevented from coming into contact by a thin strip of mica.

If the line-wire is struck by lightning, the discharge takes place to earth through the protector, the two plates becoming oppositely charged by induction, and a spark passing between them. . . .

The ordinary currents have not a sufficient tension to pass the air-space in the lightning protector, but go to earth through the more circuitous route of the instrument.

The test by simple inspection would seem to be the best for the conductors above ground. A resistance-test could only be applied with advantage where there were no slip-joints, and where the conductors were difficult of access.

As regards the earth connection, simple inspection may frequently be the easiest and most satisfactory test also. It is known by experience that ten superficial feet of metallic conductor in contact with *wet earth or water* is sufficient to carry off safely any discharge of lightning. If then we can by inspection ascertain that in *dry summer weather* we have such a connection we may be satisfied. Should it be difficult to inspect, then the electrical test should be used, and I should prefer the Wheatstone balance test. . . .

It might happen that the connection between the conductor and the plate, or tube, or mass of metal forming the earth, was imperfect, owing to oxidation. In such a case the resistance would appear considerable, yet in reality the connections might be practically good as regards lightning, as a spark would pass from the conductor to the plate, etc., and from its large surface of contact with water it would escape freely and harmlessly. . . .

Hence I consider that in all possible cases inspection is the best test, but that electricity carefully used may assist the inspection in cases where the earth connection is difficult to get at.

It is most necessary that tests or inspections of earth connections should be made at the driest time of the year. In wet weather they must always be unreliable.

In rocky or very dry sites good earth connections are most difficult of attainment. . . .

I do not think that tests made by weak currents are of any very great value in deciding on the resistance of earth connections intended to carry off a great charge of electricity at one instant of time, as in the case of a lightning discharge. H. SCHAW, Colonel, R. E.

24th January, 1879.

P. S.—Were all systems of lightning conductors arranged so that expansion and contraction might be allowed for by S bands of flat iron instead of by slip-joints, and all other joints welded or soldered, electrical resistance tests could be applied without difficulty, and I consider this would be very desirable.

## NEW EXPERIMENTS WITH THE ELECTRIC ARC.

A few weeks ago MM. Jamin and Maneuvrier, in the Paris Academy, described some instructive experiments in which the electric arc was maintained between various "electropyres" (to use a recently coined word), by action of a Gramme machine with alternating currents. With two quite similar carbons as electropyres, there is no deflection of a galvanometer in the circuit, the two rapidly successive contrary currents neutralizing each other. But, with one carbon thick, the other thin, there is permanent deflection (as though a battery were inserted in the circuit); the current from the large carbon to the small dominating over the other, and giving a differential current. There is also a differential current where the electropyres are a mass of metal and a carbon point. With lead a deflection of 29° was had; with iron, 30°; with carbon, 31°; with copper, 60°; with mercury, 70°. In the case of zinc, the current, at first as strong as with copper, falls off, probably owing to formation of oxide.

The electromotive force of the differential current is small, and about the same, for lead, iron and carbon. For copper it is equivalent to 50 Bunsens, for zinc (at first) to 66, while mercury shows 103·7. It is proved that the first three substances offer the greatest resistance, while copper and mercury offer the least.

The differential current can only be explained in two ways: by a difference in the resistance, or by an inequality in the inverse reactions of the arc in one direction or the other. As no difference of resistance was observed with change of direction, it is concluded that the current in question is due to a particular property of alternating currents.

Whatever the explanation, it is clear that, the arc once produced with mercury, the differential current quite alters the action of the machine. One system of currents is, if not extinguished, considerably weakened, and the other constituted by excessive currents of greater intensity and duration. The commutator by which alternating-current machines, like those of Nollet and Meritens, are rendered available for chemical operations, might be replaced automatically by one or several arcs formed between a bath of mercury and a carbon point. It remains to ascertain the economic conditions of this transformation.

The effects obtained from the Gramme machine, with alternating currents in the electric egg, are remarkable. The two currents contribute equally (say the authors) to the phenomenon, which is that of Geissler tubes, but which assumes incomparable brilliancy, owing to the considerable quantity of electricity which passes and rapidly modifies the appearances observed. The carbons get heated, redden, and reach a pale white, not only at their extremity, but throughout their length; then they are rapidly volatilized by the combined effect of heating and of the currents. Whatever the cause of this volatilization, it is certain that a carbonaceous matter spreads in the state of vapor. The globe gets filled with a blue gas, like vapor of iodine, deepening in hue to indigo. The vapor is abundantly condensed on the glass, rendering it opaque. The authors avoided this termination by using instead of single carbons two bundles of crayons, diverging from the rheophores, conewise, toward each other. Here the currents are divided into a large number of effluves, less intense than the single effluve; all the carbons are illuminated at once, and less the more numerous they are. The volatilization is nearly *nil*. A still brighter effect was obtained with copper rods.

In a more recent paper MM. Jamin and Maneuvrier have described some striking modifications of the arc when sulphide of carbon vapor is introduced into the vacuous space. The carbons in these experiments were parallel—fixed at the base, and separable at the top by a simple mechanism. With a vacuum as complete as possible in the receiver, the arc of course does not form; there is the Geissler tube phenomenon; but when a few drops of sulphide of carbon are introduced, increasing the pressure about 0.05m. or 0 06m., one sees the arc between the points, and it persists as they are separated. At this moment there is, as it were, an explosion of light, so bright as to be unbearable, incomparably superior to the usual brilliancy of the arc. Looking through colored glass, one observes the arc to be of horseshoe form, or like a large Omega, resting with its two ends on the carbon points, and about 0 05m. in height. A long flame rises vertically from it. The points of the carbons seem red and very brilliant, but the arc is pale-green, and, as this color dominates, the whole room is as if illuminated by a Bengal

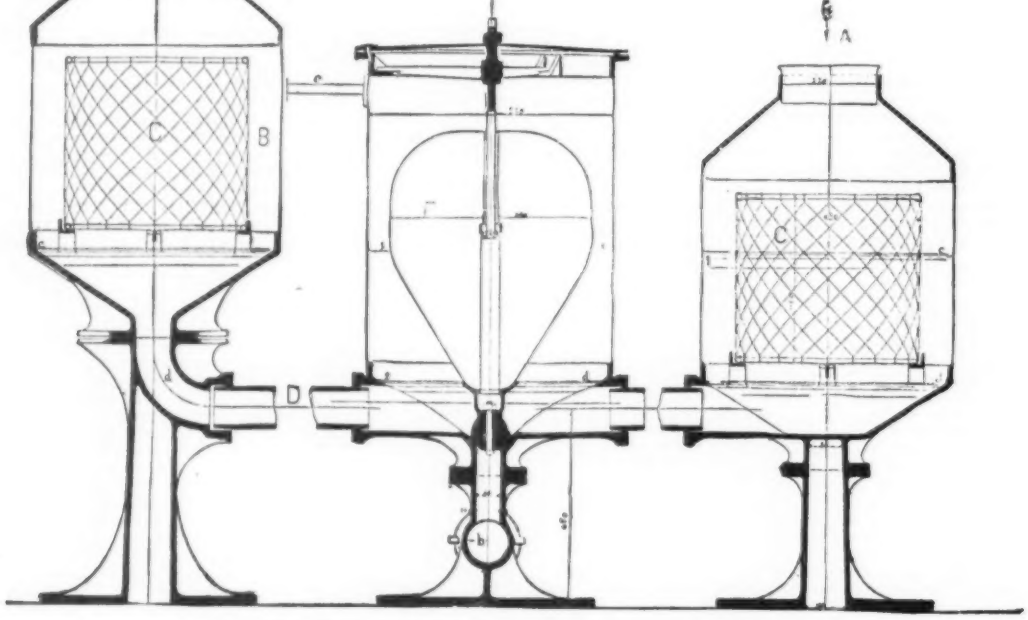
flame with copper in it. The brilliancy increases with increase of tension of the vapor; but, the resistance also increasing, the arc may go out and have to be started again and again.

The spectrum of the light is formed of four channeled spaces in the red, the yellow, the green, and the violet, very similar in appearance, though the green is the most luminous. They probably obey the same harmonic law, which remains to be discovered.

While these appearances are in progress, a chemical action takes place. If air have remained in the receiver, the sulphide of carbon burns incompletely; a cloud of sulphur fills the space, and is deposited on the glass; the carbon burns alone. If the air have been well removed these clouds do not form; a brown deposit is produced on the glass, and becomes black. This deposit is volatile. Its odor recalls that of sulphur. "It is evidently a compound of sulphide and carbon; perhaps a protosulphide corresponding to carbonic oxide, perhaps an isomeric combination of ordinary sulphur. One finds, indeed, neither a deposit of sulphur nor one of carbon, and the crayons have neither lost nor gained. It is probable that the sulphide of carbon is dissociated, the sulphur volatilized, the carbon in vapor disseminated in the arc, and that this carbon and this sulphur recombine in the flame to reconstitute a combination under different conditions; but this is merely a conjecture, no analysis having yet been made. *En résumé*, this experiment is remarkable for the extraordinary quantity of light produced, for the size of the arc, for its color, for the composition of its spectrum, and for the chemical actions which take place. It is not probable that it could ever be turned to advantage for illumination, on account of the color, unless for lighthouses and signaling at a distance."

## BERLIER'S PNEUMATIC SYSTEM OF SEWAGE.

IN May, 1880, Mr. Berlier, Director of the Lyons Company of Sewages and Fertilizers, began laying the line of pipes which now does away with the carriage of sewage by boats on the Rhone—a method of disposal of the foul material that had been the object of well-founded recriminations on the part of the population inhabiting the river shores.




PNEUMATIC SEWAGE APPARATUS.

A.—Inlet. B.—Receiver. C.—Metal Basket. D.—Communication of the Receiver with the Evacuator, E. F.—Float.

The establishment of this system has been the subject of a very important report, which was asked for by the Prefect of the Rhone of a committee presided over by Mr. Delocre. The conclusion of the report reads as follows:

"To sum up, the committee estimates that the experiment made by Mr. Berlier is susceptible of very important results, and that it may be the starting-point of very great improvements in sewage service."

Since this, the Municipal Council of Paris has authorized an experiment to be made of the Berlier system over a route running from Levallois-Perret to the Quartier de la Madeleine. The works at which the air-pump is located are situated at Levallois-Perret, where the two collectors meet. The pipes are laid along the footway of the shore collector as far as the Place de la Concorde, a distance of about 3 kilometers. In this distance there are embraced four siphons. The pipes are 150 millimeters in diameter on the main line, and those of the branches from the neighboring streets have a diameter of 100 millimeters. The first branch laid was that in Rue de la Pépinière, with a siphon under the descent to the sewer. A series of apparatus has been installed in the barracks in this same street, which contain about a thousand men.

This installation comprises twenty-five receiving apparatus and eight evacuators.

The *receiving apparatus* is a simple metal basket, having a vertical axis, and being capable of revolving around the latter, and of thus forming a sort of hydro-extractor. Centrifugal force effects a filtration of the materials contained in the basket, the latter being capable of retaining only such matters as are entirely undecomposable, and that cannot, as a consequence of their hardness, be divided. All the soft, soluble, or diluted materials that have traversed the meshes of the receiver flow into an evacuating apparatus, which comes next in order. The basket of the receiver rests on cross-pieces, and can be taken out and replaced very easily. The *evacuator*, which is circular in form, is provided with an ovoid float, whose lower extremity, containing a rubber valve, rests on the general evacuation pipe that is designed to carry off the materials. In this pipe there is maintained a constant vacuum of 0·15 meter of mercury. When the level of the diluted materials rises high enough in the evacuator to lift the float, the materials are sucked into the pipe and carried off with great rapidity. When the level lowers, the valve falls back, and the hydraulic closing which results from this arrangement prevents any expansion of the foul gases. The receiver is emptied from time to time of the foreign bodies that it has retained.

It would seem difficult, at first sight, to keep up a proper and constant vacuum in the conduit; yet it has been done, nevertheless, by making use of lead joints. The vacuum reached has been as great as 0·70 meter of mercury, with very slight entrances of air. It was produced by means of an air-pump 0·6 meter in diameter, and having a 0·6 meter stroke. As fast as the sewage materials make their appearance they are thrown out by a rotary pump located at the extremity of the discharge-pipe. The quantity of material sucked into the pipes, in the experiments at Paris, was 9·71 liters per second, and the results were very satisfactory.

Both the receiving and evacuating apparatus in this system are hermetically closed, so that any one can go into the places where they are located without any fear of being discommoded by bad odors.

The whole operation is performed with regularity. The foreign materials contained in the baskets are put into a boiler-plate receptacle and carted off to any place selected for their reception. The works containing the air-pump may be located in the very center of the most populous quarters, for the gases sucked up are forced into the pipe that serves to carry the sewage to the works, where it is to be transformed into ammoniacal products, and that, too, without any communication with the air.

## HEALTHY HOMES.

Robert Rawlinson, C. E., has given the following admirable rules for securing healthy houses, in his "Letters and Papers on Sanitary Questions".

The following are rules that should be attended to:

The subsoil beneath a house should be naturally dry, or it should be made dry by land draining.

The ground floor of a house should not be below the level of the land, street, or road outside.

A site excavated on the side of a hill, or steep bank, is liable to be dangerous, as external ventilation may be defective, and the subsoil water from above may soak toward and beneath such houses. Middens, ashpits, and cesspools, if at the back, must also taint such basements.

The subsoil within every basement should have a layer of concrete over it, and there should be full ventilation.

Cesspools, cess-pits, sink-holes, or drains, should not be formed nor be retained within house basements.

The ground around dwelling-houses should be paved, flagged, asphalted, covered with concrete, or be graveled.

Outside channels should be in good order, and be regularly cleansed.

House eaves should be guttered and spouted.

Swill tubs should not be near doors or windows.

Pigsties should ever be at a distance; and, where pigs are kept, there should be rigid cleanliness. Improperly keeping pigs has caused more human sickness and destroyed more life than all the battles the country has been ever engaged in.

Garden plats should, of course, be in order, and be properly cultivated.

Many houses, from the mansion to the cottage, are unwholesome for some of the following reasons:

1. Damp and unventilated basements.
2. Cesspools and foul drains within the basement.
3. Rotten timber in floors and skirtings and tainted wall papers.
4. Kitchen sinks in improper places and unventilated.
5. Water closets in improper places and unventilated.
6. Rooms without adequate means for ventilation.
7. Water cisterns and pumps in improper places, supplying contaminated water.

These defects should be remedied by landlords. Houses are also unwholesome from accumulated dirt, carelessness, and personal neglect. As when:

1. Rooms are not sufficiently cleansed.
2. Carpets are left down too long and never swept.
3. Windows are seldom opened.
4. Water closets are dirty, neglected, and without ventilation.
5. Dirty beds are unmade and shrouded by dirty hangings.
6. Dirty wardrobes, and dirty clothes' closets.
7. Nooks, corners and shelves which are never dusted.

There are points of construction to be attended to which I will name, so as to put them on record for the remembrance of those who may, at some time or other, build cottages or small houses, or be in communication with those who do build, or are going to do so.

Do not build on heaps of rubbish, fillings in with cesspool refuse, chemical waste, or on swampy ground which cannot be drained. Thousands of houses have been so placed, and are now being so placed in the suburbs of our towns.

A bed of concrete over the site of cottages will vastly modify otherwise objectionable positions; but, indeed, a bed of concrete should be used in all cases.

To ventilate stairs and passages, open the staircase or passage window, or both, by drawing down the top sash several inches in summer, one or more inches in winter, and in some cases screw the sash fast, so that these windows must be open all the year round; if there is a sky-light above the staircase, let there be ventilation here which cannot be closed. The result will be improved health to the family. Pay no attention to any casual remark, "How cold your staircase is!" Let the ladies put on an extra shawl. But the remark will seldom be made.

Schools as a rule are very defectively ventilated, ordinary flat-ceilinged rooms are totally unfitted for public schools. The space should be open up to the roof-ridge, and this should be louvered.

Nurseries and children's rooms should be permanently ventilated. Dormitories for children should have ample ventilation; clothe the children warmly, cover the beds warmly, prevent direct draughts, and the cool air will not injure.*

Avoid flue ventilation of every sort; let the fresh air come in as direct as possible. Night air is the only air you can have at night, so do not fear it. Dread foul, because tainted, air manufactured within the rooms. Any outside fresh air is better than lung and skin tainted inside air.

## GERMAN WATER-CURES.

THE prominence of baths and mineral waters in German therapeutics is very noticeable. Large works, like Ziemssen's, are devoted to Balneology alone. This fact is due, in great part, certainly to the large number of medicinal springs to be found in that country as well as in Austria and Hungary. It has become very much the fashion for city people of the Continent to go to some springs for the summer and there recuperate. The question, says a German author, presents itself every summer to the invalid and to those exhausted by winter's work or gayety, "to what bath shall I take my enlarged liver, my unhappy stomach, or my deranged nerves?"

Dr. Kämpf, in the *Badearzt*, attempts to answer this query, in part, and gives an entertaining sketch of some of the health resorts of Austro-Hungary.

Carlsbad is placed at the head of the list. Liver troubles, gravel, obesity, diabetes, catarrhs of all kinds, will, we are assured, disappear entirely, or to a great extent, under the beneficent influence of its waters. Marienbad has a very similar reputation.

Franzenbad is a curious place and very different from the former. It is visited almost entirely by women. Those who are suffering from the effects of child-birth, who are worn out, feeble, and anæmic, go to Franzenbad and drink its chalybeate waters.

* Bed-rooms may be permanently ventilated by the insertion of a panel which will open, or of a box in the wall close underneath the ceiling, having the outside and inside faces covered with plates of perforated zinc. The opening in the wall should be equal to 36 square inches, that is, 12 by 3 inches.

Permanent ventilation by windows may be obtained by raising the bottom sash a few inches, closing the open space, the outside air coming through betwixt the central sash frames. The current will be a thin current of air upwards.

The number of hot sulphur baths, which are reputed valuable for skin diseases, rheumatism, and gout, is quite large. It includes Trenezin-Teplitz, Pystian, Warasdin, Gastein, the Brennerbad, and Neuhaus, which latter place has also a reputation for nervous diseases. Most of the above places are frequented chiefly by invalids, and are rather dolorous spots for those who are not very ill and wish amusement as well as medicated water. For this latter class such places as Baden-Baden, Wiesbaden, Hamburg, Giesshübler, etc., are especially adapted. The waters of the last-named place are recommended as among the most pleasant to the taste of all.

Patients with chronic skin diseases choose either the indifferent thermal or the sulphur baths. Dr. Kämpf asserts that, in his opinion, the most efficient waters for these diseases are those of the Bad Lenk in Switzerland. He speaks in particular of its effects upon psoriasis.

Scrofulous patients and those suffering from venereal disease go to Hall, Luhatschowitz, Lipik, etc. Also to Schroth's Hunger or Breadcure in Lindewiese. This Schroth was originally an ignorant peasant, who conceived a theory of disease and based upon it a system of treatment which made him widely famous. He deprived his patients of food almost entirely, giving them only an occasional piece of bread and drink of wine. They were sweated and purged at the same time. When he had sufficiently reduced them, and the "materia peccans" was driven out, he fed them freely again. His results were very brilliant, especially in some bad forms of syphilis. Priessnitz, "the discoverer" of the cold-water treatment, for a long time carried on a rival establishment at Gräfenberg.

The Tyrol has as many as fifty-five different medicinal springs. None of them are much developed, however. There is an average of half a dozen patients living near each. One of them, at Roncegno, contains a little arsenic.

Some of the mineral waters are reported to have certain fecund properties; for example, the Bubenquelle at Ems. How much they deserve the reputation is not said. But sterile women go there, and are satisfied.

The above somewhat random facts may serve to remind American physicians that we have mineral waters also which are probably quite as good as those of Germany. Their actual medicinal value, however, has not been studied carefully and impartially to any extent. But we might profitably utilize our "water-cures" to a greater extent than is now done.—*The Medical Record.*

## SOME CHEMICAL REACTIONS.

ATTENTION has recently been redirected to the importance to the photographer of having all his bottles well labeled, as, otherwise, very fatal errors might occur; but, even when this recommendation is conscientiously fulfilled, cases occasionally occur in which the inscription by some means or other becomes quite illegible, either by the paper itself slipping off or by the writing being destroyed by chemicals. If in such a case we would not run the danger of mistaking the chemicals one must be acquainted with a few simple reactions by means of which any doubt might be ended. If one were really to proceed to analyze them the task would be a difficult one, to which only a chemist would be equal. But, among the limited number of chemicals present in a photographic laboratory, there are always but a certain few between which a doubt is possible, and which render the task considerably easier. For some of the chemicals of most frequent occurrence in photographic practice the following simple methods of recognition are given:

### A.—ACIDS.

The number of true acids used by themselves in photography is very small, and it is very easy to distinguish them as such. They all turn blue litmus paper red.

1. *Sulphuric acid*, when dropped into a solution of calcic chloride or one of sugar of lead, gives a snow-white precipitate of sulphate of calcium or of plumbic sulphate respectively.

2. *Hydrochloric acid* is unmistakable from its property of changing a solution of nitrate of silver to chloride of silver. It differs by the whiteness of the color of the precipitate at first from hydrobromic acid and hydriodic acid, which give more or less yellow precipitates.

3. *Nitric acid* stains the skin, wool, silk, and pine wood a permanent yellow. When concentrated is does not attack iron, tin, and silver, yet the solution commences as soon as water is added. If it have the so-called nitrous smell, and consequently contain nitrous acid, it colors dilute iodide of potassium and starch a deep blue—a property which is imparted to the pure acid if one throws into it a little iron vitriol.

4. *Hydrobromic acid* gives a pale yellow precipitate with nitate of silver. If a little chlorine water be added to it, and it be shaken up with sulphuric ether, it becomes brownish-red.

5. *Hydriodic acid* gives a deep yellow precipitate with silver nitrate. If a little nitrite of potassium be added, and it be shaken up with ether, it becomes a dark reddish-brown. Chlorine water also acts here as with hydrobromic acid, while the nitrous salt does not decompose hydrobromic acid.

6. *Acetic acid* is easily distinguishable by the smell.

7. *Oxalic acid.*—One part dissolved in nine parts of cold water, when neutralized with an alkali and added to a solution of chloride of calcium, immediately gives a white, crystalline precipitate of calcium oxalate.

8. *Gallic acid.*—Colorless, silky-looking, shiny needles. It dissolves with difficulty in cold water, but easily in alcohol and ether. With chloride of iron and ferrous sulphate the aqueous solution gives a bluish-black precipitate. It is dissolved by warming with concentrated sulphuric acid, and, on the addition of water, reddish-brown grains are thrown down.

9. *Tannin.*—Sometimes colorless, sometimes slightly yellowish, very soluble in water, alcohol, and ether. On the addition of water the solution in ether separates into three films. The aqueous solution with ferrous salts gives a bluish-black precipitate (ink). It is precipitated from solutions by sodium chloride, potassic acetate, starch flour, albumen, and gelatine.

10. *Pyrogallic acid* is not a true acid, and, therefore, does not turn blue litmus paper red. With ferrous salts it gives a blackish-brown tint, has a very penetrating smell, and is very soluble in water, alcohol, and ether.

11. *Citric acid* is very soluble in water and alcohol. It gives no precipitate with cold calcium chloride, but when heated with it to boiling point gives a precipitate which is insoluble by a potassic salt.

12. *Tartaric acid* is very soluble in water and alcohol. After a time, particularly when stirred, a concentrated solution in a potassic salt gives a crystalline precipitate of tartar. When cold it gives with calcium chloride a precipitate soluble in potassic lye, but thrown out again as a jelly when boiled.

13. *Salicylic acid* is difficult to dissolve in cold water, but easily dissolved in alcohol and ether. With ferric salts it produces a deep violet tint. When methylated spirit and sulphuric acid are poured over it, it smells like concentrated essence of maitrank (a decoction of woodruff over which wine has been poured).

### B.—SALTS.

1. *Salts of potassium* color the flame of a spirit lamp and of a Bunsen burner violet, when that color is not overcome by the admixture of sodium salts; but, even in the latter case, the violet tint may be recognized by examining the flame through a piece of dark cobalt blue glass, which does not transmit the yellow light of the sodium flame. A solution of platinum chloride precipitates a yellow granular precipitate from potassic solutions. In solutions of potassic salts tartaric acid gives after a time, particularly when stirred, a crystalline precipitate of tartar.

*a. Monocarbonate of potassium* effervesces under the action of acids. With nitrate of silver it gives a pale yellow precipitate of carbonate of silver, but without effervescence.

*b. Bicarbonate of potassium* behaves like the above, except that it effervesces with nitrate of silver.

*c. Neutral potassic oxalate* has a neutral reaction and gives a precipitate at once with chloride of calcium, the precipitate being soluble in nitric acid.

*d. Chloride of potassium* changes nitrate of silver to white chloride of silver, soluble in ammonia (like hydrochloric acid).

*e. Bromide of potassium* (see hydrobromic acid).

*f. Iodide of potassium* (see hydriodic acid)

*g. Cyanide of potassium* has a characteristic smell. Dissolves the silver haloid salts.

2. *Salts of sodium*, even in minute quantities, color the flame of a spirit lamp or of a Bunsen burner a deep yellow. The individual salts recognizable as above are remarkably soluble. Others worthy of note are:

*h. Borax* has a slightly alkaline reaction. One part requires twelve parts of cold water to dissolve it. If litmus tincture reddened by glacial acetic acid be added to the solution until the red color has *almost* disappeared, dilution with water will immediately cause it to turn blue. In front of the blowpipe it takes the color of the various metallic oxides heated in it.

*i. Phosphate of soda* dissolves in four parts of cold water, and is colored yellow by nitrate of silver; the precipitate dissolves in nitric acid.

*k. Acetate of soda*, when mineral acids are added to it, smells strongly of vinegar.

*l. Tungstate of soda.* By boiling with sulphuric acid in a test tube the tungstic acid is thrown out as a yellow powder.

*m. Hyposulphite of soda* dissolves chloride, bromide, and iodide of silver.

3. *Salts of ammonium*, if a lye of soda or potassium be added to them the characteristic smell of ammonia is evolved. Besides the haloid salts and carbonate of ammonia, which may be distinguished as the corresponding potassium salts are, the following are also often used:

*n. Sulphocyanide of ammonium* is colored a deep red by even minute traces of ferric sulphate.

*o. Ammonium sulphide* is colorless, but becomes yellow when exposed to air; it has a strong smell of rotten eggs.

4. *Salts of lithium* color the flame a deep vermilion red, but are not precipitated in dilute solutions of carbonate of potassium or soda.

5. *Salts of strontium* color the flame a deep purple, and are precipitated in dilute solutions by carbonate of potassium or soda as carbonate of strontium.

6. *Salts of baryta* color the flame green, are thrown down by potassic chromate as a yellow, and by alkaline carbonates as a white precipitate. Sulphuric acid forms insoluble sulphate of baryta.

7. *Salts of calcium* are thrown down by carbonates of alkalies, and, above all, by oxalic acid and its salts, as a white precipitate of carbonate and oxalate of calcium.

8. *Salts of magnesia* give a gelatinous, white precipitate, with carbonates of alkalies and lime water.

9. *Salts of alumina.*—Alum, for example, is thrown down as a white precipitate by carbonates of alkalies; the well washed precipitate dissolves in acids without effervescence.

10*a*. *Ferrous salts* are reduced by alkaline carbonates to a white, rapidly-darkening, ferrous hydrate, with yellow prussiate of potash (ferrocyanide of potassium). On the addition of air it becomes a pale blue; with red prussiate of potash (ferricyanide of potassium) it becomes a dark blue. With sulphocyanide of potassium and sulphocyanide of ammonia and tannin there is no change of color at all.

10*b*. *Ferric salts* are converted by alkaline carbonates into brown ferric hydrate. By yellow prussiate of potash it is precipitated as a dark blue color, and by tannin as a blue-black (ink), while red prussiate of potash colors the solution brown, and sulphocyanide of potassium colors it blood red. The individual salts requiring special notice are:

*a. Iron vitriol* (ferrous sulphate), a reaction of the suboxide salt, which is seldom free from oxide. A beautiful green.

*b. Sulphate of ferrous ammonia* is oftener free from oxide, therefore gives pure reactions. Pale bluish-green.

*c. Chloride of iron* is soluble in alcohol; ether separates it from the aqueous solution. Reaction of the oxide salt.

*d. Yellow prussiate of potassium* (ferrocyanide of potassium) gives Berlin blue with iron chloride.

*e. Red prussiate of potassium* (ferricyanide of potassium) gives Turnbull's blue with iron vitriol (ferrous sulphate).

*f. Ferrous oxalate* is a yellow powder. When dissolved in potassic oxalate, gives the reactions of the suboxides.

11. *Salts of silver.*—The reactions of the soluble chlorine, bromine, and iodine salts are well known, also nitrate of silver.

*a. Chloride of silver*, originally white, when exposed to light, it turns from violet to chocolate brown. It is soluble in ammonia and in the fixing salts.

*b. Bromide of silver* is of a pale yellow, but becomes a pale grayish-violet when exposed to light, and is less soluble in ammonia.

*c. Iodide of silver* is deep yellow, and almost insoluble in ammonia.

*d. Sulphate of silver* is precipitated by sodium chloride. The fluid poured off exhibits the reaction of sulphuric acid.

12*a*. *Mercurous salts.*—Solutions of potash and of soda precipitate black suboxide. Monocarbonate of soda (washing soda) precipitates it yellowish, red prussiate of potassium brownish-red, iodide of potassium greenish yellow, and chromate of potassium brownish-red.

12*b*. *Mercuric salts.*—Potash and soda in solution precipitate the yellow carbonate of soda red brown, red prussiate of potash yellow, and iodide of potassium at first yellow and then a magnificent scarlet-red.

*a. Bichloride of mercury* (perchloride of mercury, corrosive sublimate) precipitates albumen and gives red iodide of mercury with iodide of potassium (eight parts to ten of potassic iodide).

*b. Iodide of mercury* is a splendid red; becomes yellow when heated, and red again on cooling.

13. *Gold salts* are generally used only as chloride of gold, occasionally also as chloride of gold and potassium, and so on. A solution of one part of stannium subchloride and two parts of stannium chloride dropped in gives a splendid precipitate of gold purple.

14. *Salts of platinum.*—Platinum chloride only is used; it gives a yellow precipitate with potassic salts.

15. *Palladium chloride* gives a red precipitate with chloride of potassium.

16. *Iridium chloride.*—On the addition of potassic lye a red precipitate of potassium and iridium chloride is at first thrown down, but is redissolved on adding more of the potash solution. Nitrate of silver in iridium chloride forms a blue precipitate, which soon loses its color again.

17. *Schlippe's salt* (sodium sulphate of antimony, lately recommended for the intensification of emulsion plates) is composed of large colorless or yellowish crystals. When exposed to air it smells like rotten eggs. It should be kept under spirit containing soda.—*F. Stolze, Ph.D., in British Journal of Photography.*

## THE CHEMICAL INDUSTRIES OF ITALY.

THE following interesting sketch of the present state of the chemical industries of the Italian kingdom is from the *Chemiker Zeitung* of recent date:

### SULPHUR.

This of course is the most important branch of all these industries both as regards the total production and the number of workmen employed therein. At present there are in all about 300 sulphur mines that are being worked, of which 275 are in Sicily, 20 in the Romagna, 3 in the Neapolitan States, and 2 in the former papal dominions. It is nearly all worked in the most primitive way, by fusing the sulphur minerals with burning sulphur, which causes an average loss of about 50 per cent. of all the sulphur made in Sicily, and 43 per cent elsewhere. Other methods of working it, such as using closed iron smelting cylinders, or superheated steam, have only been introduced in very few works.

The total quantity of sulphur produced annually for the last few years, has been 400,000 tons, worth nearly eight million dollars; 21,000 workmen found employment.

### BORACIC ACID.

The free boracic acid that escapes from the fumaroles of Tuscany and the volcano islands is caught in the former place by conducting the steam and vapors that escape from the cracks in the earth into basins of water, where the greater part of the acid is condensed. The water, when it has dissolved a certain quantity of acid, is concentrated in iron kettles and then left to crystallize in leaden vessels. The crystallized acid is afterwards dried in suitable chambers. The fumaroles furnish the heat necessary for the operation.

In the volcano isles the boracic acid vapors are not passed into water, but into a heap of débris and rubbish, where the acid is precipitated, and is afterwards leached out and the lyes worked up.

The total production of boracic acid for the past six years has averaged 2,823 tons a year. The product is all exported mostly to Europe and the United States, where it is converted into borax. A small portion goes to Germany. Only an insignficant quantity is used at home for making borax, and that only by order of the owners of the works. Boracic acid pays an export tax of 22 lire ($4.40) per ton.

### SULPHURIC ACID.

In 1879 there were 13 sulphuric acid works in Italy, of which only one used pyrites, and the rest sulphur. Only four are of much importance; one in Milan, one in Turin, one in Grosseto, and one in Naples. Three qualities of acid are made, 50°, 60°, and 66° B., of which 7,140 tons, 2,210 tons, and 3,520 tons respectively, were made in the year named, worth $270,000. The acid of 50° B. is used mostly by manufacturers of superphosphates and stearic acid, while that of higher strength is preferred for making alum. The total production of sulphuric acid is less than the home consumption, so that the importation of this article is gradually increasing from year to year.

### HYDROCHLORIC ACID.

This acid is only made in three factories on a large scale; two of these are at Milan, and one in Orbetello. The annual production is perhaps 2,000 tons, while the consumption is estimated at one-fourth more.

[Hydrochloric acid vapors escape in immense quantities from the crater of Vesuvius and thereabouts, as shown by the formation of native chloride of iron, called *sulphur* by the guides, and of salammoniac. No practical method has been devised for collecting and utilizing this valuable product of nature's laboratory.]

### NITRIC ACID.

Only two factories, one in Milan and the other in Turin, make this acid for the trade. Other factories that used to make it were connected with dynamite factories, and have been consolidated with them. The consumption of nitric acid is also greater than the home production.

### SODA.

The manufacture of carbonate of soda from common salt directly is not carried on in Italy. There are only two small establishments where the sulphate of soda resulting from the manufacture of hydrochloric and nitric acids is converted into carbonates, and they produce yearly some 2,000 tons of crystallized soda, which stands opposed to an average (for the last six years) importation of 12,500 tons. In 1877-8 an attempt was made to introduce the Solvay soda process, but was soon abandoned, owing to unsatisfactory results.

### SALTPETER.

There are at present two large factories in Sampierdarena and Genoa, engaged in making potash saltpeter, of which the latter is under control of the government. It is made exclusively from Chili saltpeter by decomposition with German chloride of potassium. The saltpeter beds of former times have everywhere disappeared. Besides the above-mentioned saltpeter works, a large portion of the numerous gunpowder factories make all the saltpeter they need by the same process.

ALUM.

In recent times the well-known Roman alum has lost much of its former importance, and hence the alum works at Civita Vecchia, which belonged to a French company and made use of the oft-mentioned Tolfa alumite (or alum stone) have had to reduce their production considerably. Two factories at Naples are making ammonia alum, and one Milan firm makes sulphate of alumina by the action of sulphuric acid on kaolin. Just now alum is exported from Italy in considerable quantity; but the progress of alum-making in other countries renders it doubtful whether this export trade can long be maintained at its present state.

MAGNESIA.

Caustic magnesia and its salts are made on a large scale in three places in Northern Italy from the dolomite of the Alps. As magnesia can be made in other countries by much cheaper processes, it is no wonder that Italian manufacturers complain of the foreign competition. In fact, the importation of these compounds is steadily increasing.

WHITE LEAD.

There are 14 white lead factories running in Northern Italy, chiefly in the province of Genoa. With two exceptions, they are of subordinate importance. Formerly the Dutch process was in general use for making white lead, but a few years ago the two largest factories adopted Dahm's method, in which the lead is drawn in wires and exposed alternately to the action of air and of acetic acid, and the resulting basic acetate of lead is decomposed by carbonic acid. The materials employed are Italian lead and French acetic acid, as the latter is not made in a concentrated form anywhere in Italy. The annual production of carbonate of lead is from 1,400 to 1,500 tons, of which 350 tons only are exported.

ARTIFICIAL FERTILIZERS.

The manufacture of fertilizers, which was almost unknown a few years ago in the Apennine peninsula, has recently found many representatives, especially in the north, and 14 firms were represented in this branch of the Milan Exposition recently. In the aggregate there are at present about 40 fertilizer factories, but neither singly nor collectively have they the importance that we are accustomed to in Germany. This will be seen from the fact that most of them are engaged in making special fertilizers for wheat, rice, corn, wine, olive, etc., more like retailers. There is no government control over these as there is in Germany, and it would be of little use, for not one-tenth of the Italian landowners would be able to form a judgment on the report. Most of the chemical fertilizers are made without the aid of any chemist.

EXPLOSIVES.

Not long since there were in Italy not less than 250 powder mills, of which not much over 100 are now running. With the exception of a few larger establishments they drag out on the average a miserable existence. There is an import duty of $30 per 220 lb. on gunpowders, so that Italian manufacturers have the privilege of putting on the market a dear and generally a very poor article. At the end of 1870 there were four dynamite factories in Italy, only one of which, that in Avigliano, is still in operation.

CARBON DISULPHIDE.

This substance is extensively used for extracting olive oil from the residues left after pressing the olive, and also for making the sulpho-carbonates which play such an important part in the war against the phylloxera. The pressed olive cake contains in most cases ten or twelve per cent. of oil, which was formerly wasted, but now ten factories extract it with carbon disulphide. The dark-colored oil obtained by its aid finds willing purchasers among soap-boilers, as it is thought that it saponifies easier and better than the pure olive oil. One French firm in Bari makes 12,000 cwt. of carbon disulphide annually.

CANE SUGAR.

The raw sugar comes chiefly from Austria and England, to be refined in the large Italian refineries. Attempts to introduce the manufacture of beet-root sugar have not been wanting. As early as 1830 it was tried in three places. All three of the factories went down after a brief existence. In 1869, again, three more such undertakings came to life, two of which suffered a like fate. Only the one in Tuscany has been able with great trouble to keep itself alive to the present time. In those acquainted with the state of agriculture there, this fiasco excites no surprise; for, if Italian agriculture is not the worst in the world, it is far from being in such a state as to succeed in beet culture. At all events, it is unfair to try to lay the responsibility of the failure on the government, as some would like to do. The Italian beet sugar industry is sufficiently protected by an import duty of $10 on the raw product and $12 50 on the refined sugar.

GLUCOSE.

This was exhibited at the Milan Exhibition by two manufacturers, but we do not know whether there is any considerable production of it, nor what raw material is used. There is a well-constructed starch-sugar factory in Milan for working corn starch, but it is standing still.

STARCH.

There is a whole series of small and medium-sized factories for making starch from wheat, rice and Indian corn. The rice starch factories, the largest of which makes four tons per day, treat the rice either with sulphurous acid or with caustic soda; the latter is preferred and its use is being extended. The starch factories of Northern Italy produce a very good product, but I have not seen any equal to Hofmann's German rice starch. That made with sulphurous acid is generally of less value, although it looks first rate, and on account of the free acid in it always makes a paste of less consistency. The amount of starch produced is not equal to the home consumption, so that the imports of this material exceed the exports by about half a million francs.

QUININE SALTS.

Two factories are engaged in making quinine preparations, the "Fabbrica lombarda di prodotti chimici," near Milan, and the Dufour Brothers at Genoa. The former works with a capital of four million francs, and has branches in Bogota and Ocana, as well as in London, Paris and Constantinople, and owns extensive plantations in Central America. The total production of quinine salts in Italy, in 1879, was 66,000 pounds. Reckoning, as Ellena does, that 22,000 pounds are consumed in the country itself, the production for 1881 may be estimated at 88,000 pounds, of which 77,000 pounds are made in the Lombard factory at Milan. The exports of this article exceeded the imports by eleven and a half million francs in 1881, and about seven million francs in 1880.

TARTAR AND TARTARIC ACID.

The crude argols collected throughout the whole country are subjected to a single recrystallization at many places, and this half-crude tartar and a large quantity of unpurified tartar is exported chiefly to France and England. So, too, the grape skins and residues from the coast go to these countries to be worked over for tartar. Only a few factories are engaged in making pure cream of tartar and other tartrates; only eight were represented at the Milan Exhibition. The number of firms that produce pure tartaric acid is still more limited.

CITRIC ACID.

It is inconceivable how totally neglected is the manufacture of citric acid. Up to 1880 one such factory existed in Messina, which, if I mistake not, was under English direction. When Messina ceased to be a free port it had to stop operations. It was said at that time that a Neapolitan firm was going to take up the manufacture of citric acid, but nothing seems to have come of it; at least this house did not exhibit either citrates or citric acid at Milan, and I believe that at present no one in Italy is engaged in its manufacture. Lemon juice is made at many places in Sicily, and represents a value of nearly three millions of francs (1881), all of which is exported, chiefly to England and France.

STEARIC ACID.

The extended use of this acid for making candles and matches has helped to bring its manufacture to quite a flourishing state in Italy. Still all the factories now running are not able to cover the home consumption, so that for the last two years there has been an average importation of four and a half million francs' worth of crude acid and candles.

SOAP.

The manufacture of soap is conducted very successfully in Northern Italy, and the raw product is very good, a considerable quantity being exported. The Italian perfumed soaps, however, are far inferior to French and English toilet soaps.

PAPER.

In 1879 there were over 500 paper mills, about half of them run by steam. Ordinary writing and printing paper is made of excellent quality; their fine papers are not all that could be desired. The use of wood fiber for paper is in its initiatory state.

COAL TAR.

In several of the larger coal gas works the light oils and ammonia water are distilled off, and the residue sold for making *briquettes*. The benzole is exported, and the ammonia water either used for making fertilizers or caustic ammonia. There are in Italy only two distilleries devoted entirely to working coal tar, and only one of them was represented at Milan, and that by very poor articles.

There is but one chemical factory such as those of Trommsdorff, Schuchardt, etc., that of Carlo Erba in Milan, and it is more concerned with the manufacture of ready-made pharmaceutical articles than preparations for chemical laboratories. Other so called "fabbriche di prodotti chimici," which is a favorite title with them, are in fact nothing but laboratories for making medical specialties or secret remedies.

Caustic soda, chloride of lime, prussiate of potash, and tar colors, are not made in Italy. The importation of these articles was as follows:

| | | | | | |
|---|---|---|---|---|---|
| Caustic soda, in 1880..... | $144,080 | in 1881.... | $164,420 |
| Chloride lime " " .... | 146,253 | " " .... | 99,874 |
| Ferrocyanide " " .... | 36,120 | " " ... | 47,250 |
| Tar colors " " .... | 858,960 | " " .... | 1,125,800 |

## THE SOCIETY OF CHEMICAL INDUSTRY.

THE first annual meeting of the Society of Chemical Industry was held in the chemical theater, Owens College, Manchester, on July 5, and, if we may judge from the age of the society, which was founded as recently, we believe, as April 4, 1881, and the number of the members attending last week's meetings, we may certainly say that the promoters of the society ought to be well satisfied with their work. The president, Professor Roscoe, F.R.S., in his address, congratulated the members on the status of the society, and mentioned that, while in June, 1881, 297 members were on the books, the numbers had since increased to 1,140. This number comprises most of the leading technical men engaged in the important chemical industries of Great Britain, as well as many other scientific men well known at home and abroad. We notice the name of Professor Abel (president-elect), Messrs. Lowthian Bell, E. K. Muspratt, H. L. Pattinson, Dr. Siemens, Professor Williamson, and many others, as among those who fill the office of vice-president. On Wednesday, Dr. Roscoe opened the meeting at Owens by giving his address. In this he stated that, if the importance of chemistry were more thoroughly recognized in the vast industries of Great Britain, much economy to the country would ensue, and that in one department alone, namely, that of coal-tar color, and colors generally required for calico and other printing, £3,000,000 were annually lost to the country, and this simply because of the greater attention paid on the Continent to chemistry than obtains in England. The president further said that the method employed in the continental manufactories was entirely scientific, the first aim being to have highly trained chemists at the head of the works, the various departments of which were also submanaged by well-trained and well-paid chemists, who personally investigated the commercial production of the various articles, and superintended the manufacture of others, which had already been brought within the charmed circle of financial success. In some of the larger color works as many as thirty to forty well-trained and well-paid chemists were employed in this way, with the natural result that the Continent very largely supplies the home demand for these and other chemicals, and when they are produced in England German chemists and German processes are frequently employed. The president's address was followed by the reading of the treasurer's report to the society by Mr. E. R. Cook, London, and the report of the patent committee read by Mr Ludwig Mond, Northwich. This patent committee was formed by the society last year to promote better regulations in connection with patent laws, with special reference to chemical patents. Steps have been taken to communicate the views of the committee to Mr. Chamberlain, with the result that attention and support were promised to the committee when legislation on the subject was more matured. At present this was quite at a standstill, so little more could be done. It was, however, proposed, on June 28, to form a parliamentary committee to watch the bill when matters would allow of this being done.

The first paper read was one by Professor Huntington, of King's College, London, on "The Mexican Amalgamation Process." In this Professor Huntington adduced new explanations of the various chemical operations involved in the processes. These explanations had been founded on numerous laboratory experiments made of course quantitatively, one result of which was to show that the formula ascribed by Rammelsberg and others to the action involved ought really to be represented by two, and that the explanation was obscured by the reversal of operations determined by the ammonia which investigators had used in their laboratory experiments. It is to be regretted, speaking generally, that the papers were not printed previously to their being read, as in the majority of cases where chemical reactions are involved it is very difficult, if not impossible, to follow their rationale; and then, again, much of the discussion on them would be more interesting, as, when they are not printed, it frequently takes the form of questions and explanations rather than a discussion properly so-called. Professor Huntington afterwards read a second paper on "The Metallurgy of Cobalt and Nickel." In this the analogy between these elements and iron was very strikingly made manifest. Professor Huntington had melted buttons of these in a Siemens electrical furnace with various results; the fracture of many being almost identical with that of pig irons which contain varying percentages of alloyed and graphitic carbon and silicon, some being so open as to approach No. 1 pig, others having a steely fracture. Professor Huntington further explained the production of malleable cobalt and nickel. This malleability was produced by the introduction of manganese, and specimens were exhibited of nickel and cobalt in the form of sheet and wire, though the latter, we believe, did not exceed about No. 8 B. W. G., and the sheets also were somewhat thick; but the fact of the malleability and the method employed are extremely interesting. Of course the connection between the latter and the Bessemer process is obvious. The carbon in these specimens was about one-tenth per cent. The other papers read were one by Dr. Otto Witt, read by Mr. Watson Smith, "On the Application of Indophenol Blue to Calico Printing and Dyeing," and another by Mr. Charles O'Neill, "On the Part of Chemistry in Calico Printing." In the evening the members dined together at Belle Vue.

On Thursday, Mr. Alexander Chance, of Birmingham, gave a description of the probable plant required for the recovery of sulphurin alkali waste by the Shaffner and Helbig process. In this important process three distinct chemical operations are involved: (1) The decomposition of the calcium sulphides in the alkali waste by magnesium chloride, by which the sulphur is liberated as $H_2S$, without being diluted with other gases. (2) The reconversion of the magnesia (MgO) thus formed into chloride of magnesium, and the recovery of the calcium from the $CaCl_2$, in the form of carbonate of lime, by the action of carbonic acid gas. (3) The recovery of the sulphur from the $H_2S$ by precipitating the S by means of $SO_2$, thus: $2H_2S + SO_2 = 3S + 2H_2O$. These, from a chemical point of view, are very beautiful reactions, and the importance of any process which has for its object the recovery of the enormous quantity of sulphur obtainable is seen from the consideration that £357,000 is annually lost as the value of the sulphur in alkali waste. Several of the speakers in the discussion which followed spoke very highly of the process, and this opinion receives its best support by the fact that many large works are proceeding with the erection of the plant necessary for it. The second paper, on "Boiler Incrustations and the Purification of Water for Technical Uses," by Mr. W. Iveson Macadam, was postponed until the London meeting. In the evening on Thursday a very successful soirée was held at Owens College, when there was an exhibition of chemical products, especially those relating to the dyeing and calico-printing industries. These and the different fabrics were shown by 140 Edison incandescent lamps, worked by two Edison machines. Professor Huntington showed the action of the Siemens electrical furnace, worked by the college Siemens machine. Among the ordinary exhibits of a scientific soirée was one the importance of which warrants its special mention, viz., a series of microscope slides, illustrating the discovery of Dr. Koch, of Berlin, of the zymotic character of consumption. The bacillæ detected by him in pulmonary tubercles were exhibited *in situ*, and allied objects in this research were also shown.

The next and last day — Friday — was devoted to excursions. Among the works visited by the members were the East Lancashire Paper Mill, the Works of the Radcliffe Printing Company, Messrs. R. Bealey & Co.'s works, and the alkali works of the same firm, the Union Glass Works, and the alkali works of Messrs. Knotz & Co., St. Helen's, the Tharsis Copper Company, Messrs. Gaskell, Deacon & Co., and Messrs. Golding, Davis & Co. Luncheon had generously been provided at St. Helen's for the members.

Altogether this meeting of the Society of Chemical Industry was, as we have said, a great success. The requirement of such a society is undoubted, and we hail with considerable gratification the establishment of a society whose distinct objects are to promote the application of chemistry in all its branches, and to promote the acquisition and practice of that species of knowledge which constitutes the profession of a chemical engineer. In our own subject—namely, that of iron and steel—the disparity as regards the scientific training between the average staff of officers in an English works and that of a continental works is manifest to any one who has an opportunity of judging. The scientific education of the actual workman is looked after in many works on the Continent, and it is uncommon to find a blast-furnace manager who is not a chemist, or a general manager who is not a man of considerable scientific attainments. There can be no question that the practical application of science to the procedure of iron and steel works is being attended with results whose importance is almost in direct proportion to such application; indeed, nothing else is to be expected if the pursuit of science is the pursuit of truth. And it, therefore, behooves us in English works to be as far as possible *en courant* with our subject, lest the advantage every day increasing with our friends on the Continent surpass those with which a bountiful nature has endowed us.—*Iron*.

A NEW METHOD OF PREPARING NITRO-ALIZARINE.—M. S. E. Simon.—If dinitro-oxyanthraquinone at twenty per cent. suspended in water is mixed with a very little caustic soda there is formed immediately a deep red solution of the sodium salt. On prolonged ebullition the color passes successively to a brown-red and purple, and the liquid is evaporated until the sodium salt is precipitated in flocks. This salt on decomposition by hydrochloric acid furnishes a yellow body, which on crystallization from acetic acid forms brilliant needles of an orange-yellow.

[Continued from SUPPLEMENT 347, page 5537.]

# ON THE CONDITION AND CHARACTERISTICS OF SOME OF THE NATIVE TRIBES OF THE HUDSON'S BAY COMPANY'S TERRITORIES *

By JOHN RAE, M.D., LL.D., F.R.S., ETC.

THE tariff of the Hudson's Bay Company is very peculiar, and is often the cause of misrepresentation, intentional or accidental. The payments made to the Indian for furs are far higher, in proportion of value, for the inferior skins, than for the finer kinds, such as the marten, silver fox, otter, etc., while for the musk rat, which at some posts forms about half the bulk of the furs, there is little or no profit. The cause for this peculiarity is, that if the Indian were to receive for a marten the same proportionate value that he does for a skin of perhaps only a tenth its price in England, he would follow up to extermination all these dearer and finer furs, as takes place when a fur country becomes occupied by settlers, as is the case in Canada.

The fair way to examine into the Indian tariff of the Hudson Bay, is to compare it with that of their neighbors, the Americans and Russians. I have known Indians come a long distance from the American side to purchase guns, blankets, etc., from the company, because they were better and cheaper than they could be obtained from their own traders. When in the McKenzie River district, I found that the Russians charged nearly double, and in some cases more than double what was charged by the Hudson's Bay Company. Nay, more, some of our naval officers on active service, one or two of whom, in their ignorance, have not been sparing in their remarks upon the company, actually gave less in payment for venison to the natives near Behring Strait, and for fish elsewhere, than the ordinary price paid by the company. For instance, the carcasses of twelve deer were brought to the ship by a Kutchin, for which a musket was given in payment. The same payment would have been given for seven or eight deer in McKenzie River, and it would have been hauled home by the people of the Fort, sometimes from three or four days' journey distant, probably more than a quarter of the venison being necessarily consumed as provisions on the way.

I have not yet mentioned that with nearly all Indians there is a certain favorite piece of deer or bird tabooed to the women, which they dare not taste under a severe penalty. The Chippewyans taboo the moose nose, the wood Crees taboo some part of the wild-goose, and the Dog-ribs taboo the reindeer head. I learnt this latter fact accidentally. We were traveling through the barren lands, and had killed some deer. We encamped beside some Indians who also had been successful, and, in the evening, a great scene of feasting took place, much roasting and boiling going on. To the extreme left, at some distance, a large fire was burning (we had come to a clump of wood), and on approaching it, I discovered that there were no women or girls there, as at the others. On asking my interpreter what was the reason, he said that fire was for roasting deer's heads, and that the women were not only prevented from eating them, but dare not even approach the fire at which they are cooked. The process of cooking is very simple; the head is cut off, a piece of stick, hooked at the end, is fixed in the nose, and this is suspended from a pole with a string, close to the fire, and made to turn round. The hair is soon singed into a black mass, and, after the proper time has elapsed, the head is taken down, and all the black crust of burnt hair is removed, leaving the skin beautifully clean and white. On eating one of these, I found it the most agreeable food I had ever tasted, far too good, according to the Indian idea, to be wasted on a woman. I fear that little can be done for these Northern Indians, unless they could be reasoned out of their prejudices and superstitions, which, with their imprudence and wastefulness, are the causes of their being so poor.

In winter, 1850-51, much of the venison we had bought from the Indians in the early part of the season was given back to them for nothing toward spring, to keep them from starving, not that deer were scarce, but owing to one of those scares or panics already mentioned, that drove the Indians from the hunting grounds, or made them too nervous to shoot straight. To show what confidence the Indian has in the white man in the interior of the territory, where other traders have not yet penetrated, if any one in this room were to be traveling there and in want of food, and were to meet an Indian who had some to sell, he would take in payment a scrap of paper or bit of bark with writing on it, which he did not understand, if told that he would receive so many skins on presenting it to the traders, as readily as any of us would take a sovereign.

The use of wine and spirits had been done away with long ago at these inland posts, and even the gentlemen in charge readily gave up their small annual allowance of wine and brandy, that the Indians might not have it to say that we took ourselves what we withheld from them. Although living on the most friendly terms, and taking a lively interest in their welfare, it is nevertheless necessary to guide and manage the Indian with a firm hand. A young man, on his first charge of a trading-post, has a very difficult part to play. He is placed at a great distance from any assistance, with perhaps four or five men, and there may be one or two hundred Indians coming in to the post, among whom there are most likely one or two young fellows, who are desirous to learn of what mettle the new clerk is composed; and it will depend on the manner in which he passes through this ordeal whether his life among them is an easy or troublesome one. As a rule, it is thought that the officials of the Hudson's Bay Company have performed their duties to the Indians fairly well. The relations between them have almost invariably been of the most friendly character, and the usual term applied to us is that of "father," "brother," or "son," according to the respective ages of the individuals. In sickness or in health we endeavor to be their friends. Such was my experience of twenty years.

## THE ESKIMOS.

Probably there are no people on the face of the earth, certainly not in British North America, about whom there is such a diversity of opinion, as there is with the Eskimos, or Innuit, as they call themselves. By the majority these are stigmatized as dirty, gluttonous, treacherous, untruthful, and dishonest; small, weak, and indolent; while a small minority find in them traits of character of the most exemplary kind, and good qualities possessed by few savages. Much of this difference of opinion arises from the season of the year in which the Eskimos are seen, and the locality where they live; for in a coast-line of fully 5,000 miles, from Behring Straits to Labrador, and to Greenland, there is a diversity of the mode of life, and a variety of character, which can easily be accounted for by circumstances, although all are evidently from the same stock, if identity of language can be relied upon in arriving at such a conclusion. Eskimos from Labrador and East Main are found to be able to communicate freely with those at the mouth of the McKenzie River, 3,000 or 4,000 miles away.

During the short summer of the Arctic regions, Eskimos are not seen to advantage, as they then wear their oldest and worst clothing; those of Greenland and the west shore of Davis Strait and Baffin's Bay cannot look particularly clean at any season of the year, as their hot, half-underground winter dwellings are filled with smoke and smuts from their fire lamps. For this statement my authority is Kane, Hayes, and some whaling captains. The Eskimos of the McKenzie River have, indeed, always shown hostility to whites, and a wild-looking, powerful set they are; no one of my crew, consisting of fairly strong sappers and miners, and sailors, could detach the hold of these fellows from the gunwale of the boat; to do this, Sir John Richardson in his boat rapped their knuckles with a stick. The reason of this hostility is easily accounted for; they are at constant enmity with their next neighbors, the Loucheux, with whom they have blood feuds. These Indians, in the course of barter with the white traders, obtain guns, which they use in their fights with the Innuit; hence, these last think us hostile to them, or at least friends of their enemies. On all the coast east of the McKenzie, the white man has been received and treated as a friend.

Three visits to the Coppermine River, and two winters among the Eskimos of Repulse Bay, gave me a most favorable impression of the natives of these places. At the former place, some of these men were tall (5 ft. 10 inches or 5 ft. 11 inches), well and cleanly clothed either in deer or sealskin dresses, at once friendly but unobtrusive, hospitable, and obliging; they readily helped us in crossing some streams, and without apparently expecting any remuneration. When presents were made them, they invariably offered something in return. As Simpson did, some twelve years before, I ordered a pair of waterproof boots for my journey across land in the autumn, and, I believe, from the very same Eskimo, who there and then took the measure of my foot. They had left the Bloody Fall (a famous fishing station on the Coppermine) before our return, but there was a very fine pair of boots dangling from a pole; so the Eskimo had kept his promise. The boots were removed, and very liberal payment in the form of knives, files, needles, etc., carefully wrapped up, and put in their place.

Some writers have said that the Eskimo is inferior in strength to the white man, but this I am inclined to doubt. When traveling from the Arctic coast to Bear Lake, in 1848, a journey of twelve days' duration, over a rough country, Albert, rather a small-sized Eskimo, carried with the greatest ease a heavier load than the sappers and miners did, the latter being usually very tired at the end of the day's march, while Albert was quite fresh, and able to walk miles afterward in pursuit of deer and other game. Ouligbuck (*père*) who had been interpreter in several Arctic expeditions, beginning with Franklin in 1825, was, although slow, a very powerful man, and his son, when with me in 1853-4, hauled a heavy sledge as well as my best sledge haulers, and only broke down one day, when he had taken a great feed of cooked seal's flesh at the snowhut of a countryman, and we had immediately afterward a somewhat steep hill to ascend through soft snow, which tried us all a good deal. Ouligbuck was on this occasion our snow-hut builder, which gave him about an hour's extra work when we encamped. In 1847, I took with me an Eskimo, named Ivichuk, on a journey of over 500 miles. He had the same daily rations as myself and the others, not too abundant; and although he had the additional labor of building our snow-hut every day, he stood the work very well indeed, although he did not like the pemmican, as food, to which he was unaccustomed. All the Hudson's Bay Company's officials who have had dealings with the Eskimos, either at Ungava, Churchill, or East Main, prefer them to any of the Indians of the territory, and the same is the case with the missionaries at Labrador. As to the truthfulness and good memory of the Repulse Bay Eskimo, I had an excellent opportunity of testing these, because some of them, when young, had been on board Parry's ships in 1823, that is, twenty four years before, and they mentioned circumstances that took place then as nearly as could be as they were told in Parry's or Captain Lyon's journal. It was the same with regard to Sir John Ross at Boothia, in 1829-33; none whom I saw, it is true, had been on board his ship the Victory; they, however, told me, with correctness, much that had occurred. They have not the gift of figures, and cannot remember dates. All important particulars regarding the fate of Sir J. Franklin's party, communicated to me through my interpreter, turned out to be correct, even to the fact that all the books and journals had been destroyed; close search has since been made, and none have been found. A story has been told, coming from some whalers, who visited Pond's Bay near 600 miles north-east of the scene of the sad disaster, that Franklin's people had been murdered by the Eskimos. I do not believe this, and will tell you the reason why.

1st. Men go to the north with hobbies, or preconceived ideas, and are naturally desirous that these ideas should turn out true; they put leading questions, and often thus make out a case that has no foundation in fact. There are a good many instances of this. Kane went up Smith Sound determined to find an open Polar Sea. His servant, Morton, found one for him, which turned out afterward to be only an open pool, such as is seen at many places in the spring.

Chief Justice Daly, President of the American Geographical Society, expressed an opinion that "Franklin had been murdered by the Indians, who had already imbrued their hands in the blood of white travelers." We know that Franklin died in 1847, and could not be alive with his party in 1848. We know also, that the only Indians that the unfortunate men could have met, were those that not only had never killed a white man, but were of the tribe who had nursed Sir J. Franklin and his people on a former Arctic expedition, when at the point of death from starvation, with a tenderness and care worthy of all praise. Such is the way in which falsehoods spread.

2d. Although I specially asked the Eskimos from whom I received the information, and who were not on friendly terms with those who saw the starving white men, whether there had been any of them killed, the answer was invariably no, and the same has been the case ever since, although the natives have, since my time, been taught to drink grog by our American cousins, and would be apt to let out the secret in their cups, if there was one.

When I returned from a long journey, in 1854, I found nine or ten strong natives living near my three men, at winter quarters, on the most friendly terms, although, had they wished, they might have murdered them easily,* there being an immense temptation to do so, in the boxes full of knives, saws, files, etc., which were lying on the rocks, with no other protection than an oil-cloth. The clothes of both sexes are neat, tidy, and clean, so much so, that even after being worn for the winter, they can be used by the white man without any discomfort, a marked contrast to the filthy sheepskins which form the clothing of many easterns, abounding with swarms of active and hungry entomological specimens, by no means conducive to rest or comfort. Both Simpson and myself (after an interval of twelve years) saw on the coast, east of the Coppermine River, large bales placed on high rocks, inaccessible to animals. These, on examination, were found chiefly to contain winter clothing, which was as carefully packed away as dresses in a lady's trunk, and perfectly free from smell or impurity. Of course, we repacked the bale (which was covered with some large musk-ox skins) without removing anything, but placing inside a very handsome present of ironwork.

The Eskimos are said to be a diminutive race, but I have studied the true Londoner, and, without actual measurement of either, I am inclined to think that the Eskimos are as tall as the natives of our great city, and much heavier. When sitting, an Eskimo does not look short; the defect of stature is probably due to the shortness of the lower limbs.

On mentioning this to Professor W. H. Flower, of the Royal College of Surgeons Museum, the very highest authority on such subjects, he mentioned to me a very curious fact, namely, that of three Eskimo skeletons he had examined, two of them had each an additional bone in the vertebral column, that is, twenty-five instead of twenty-four. The women, when young, are pleasant-looking, almost pretty little creatures, extremely solid and compact, with small feet and hands, and well-formed limbs. On one occasion, my own man, a powerful fellow, accustomed to carry heavy weights, having to lift some of these young women out of a boat, they not wishing to wet their feet, told me afterward that they were the heaviest things he ever carried, and but for very shame would have dropped them. He took them up in his arms as he would a child, and hence his mistake. I have already spoken of the activity and powers of endurance of certain Eskimos in comparison with whites; I also tested their strength in lifting weights; some of my fellows, I knew, could lift 400 or 500 lbs. I found that the difference of strength between the two races was very slight, and in some cases so close that, fearing that some one might come who would excel my men or myself, I closed the competition.

I may be laughed at for saying that the Eskimos are scientific, but I think I can prove the fact. The goggles which they have invented to protect their eyes from the glare of the snow, with its narrow slit, to admit only a small amount of light, the blackened inner surface, and the peak (like that of a cap) to keep the sun off, are all perfect. The Eskimo's mode of building his snow-hut—only about six inches thick in the wall—would puzzle an architect or an engineer, until he saw how it was done. The bed-place in his snow-hut is raised above the level of the top of the low door, so that those sitting or lying upon it are out of the draught, and in the upper or warmer air of the interior. On one occasion, the drifting snow, during a gale, was cutting away the weather side of my hut. I told my men to pour some water on the snow, to harden it. The Eskimos present remarked, "It was not good to do that, as it made the house cold." Once, I found a man, when about to build his snow-hut, digging several feet down into a drift-bank for building material, although the surface snow looked in excellent condition for the purpose. On asking the reason, he said he wished to get the warm snow. This warm snow I found to be formed of much larger crystals than that on the surface. Probably, experience had taught him that it was a better non-conductor. The man strips to the waist, as if preparing for a pugilistic encounter, when going to bed during winter, and the child is carried, perfectly naked, in the hood of the mother, the object of both being the conservation of caloric. Ask ten people in England, how would they heal frost-bite? Probably, eight of the ten would say, "Rub with snow." The answer would be right if the frozen person were taken into a warm house, but wrong if he was at the time exposed to the low temperature that was freezing him. This lesson was taught me by a little Eskimo woman one very cold day; she saw my cheek white, and immediately applied her warm hand to the part, pressed it gently, and moved the skin and flesh over the bone underneath; the circulation was immediately restored, without either wetting or cooling the hand, or abrading the hard and frozen skin by snow friction. This was science and common sense. Their iced sledge runners enable them to haul a double load. The Eskimo kayak is as perfect a model for speed as the most perfect racing boat, compatible with sufficient breadth to carry a seal on deck if required. The Eskimo is the only canoeman known who can capsize his canoe, and without leaving his place, right her again. His salmon spear is the most perfect I have ever seen; and his harpoon is so formed that it cannot possibly "draw," as the whalers say; the line may break, but the harpoon head is a fixture.

The Eskimos have a tradition that they came from the setting sun, and that they crossed water, probably Behring Straits. They certainly, to my mind, give the idea of a former more civilized condition. They treat their wives kindly, are grateful for kindness, which they showed in a very delicate and pleasing manner by bringing us seal's fat when we required it, and taking no pay, because, as they said, we had been kind to some of their old people who encamped near us, and were under our care when the younger persons were away hunting. When sitting in the men's tent or my own, if they saw preparations for eating, they immediately got up to go away, but were, of course, asked to remain and share our food, if our larder was well stocked. The old folks left in our care never begged; and it was only by sending my servant to their tents that I found they were out of food. During the two seasons, the value of a sixpence was never stolen from us; on the contrary, we could with safety leave our tents in charge of some of the older people. I saw no instances of the huge feeding so often attributed to them. We are apt to forget, or many people do not know, that a mixed diet of bread and meat will be quite as satisfying as twice the weight of meat alone. Sir John Richardson was surprised to find that his sappers and miners, when at Bear Lake, consumed about 7¼ lbs., the full ration being 8 lbs. venison per day.

I have said much, and, if space would admit, could say a good deal more, about my friends the Eskimos, but I hope I have already given evidence enough, not only from my own experience, but from that of others, that I have had cause to form a high opinion of them. All Eskimo interpreters, from Augustus and Ouligbuck with Franklin, in 1826, to the present day, have proved faithful and true, sometimes under severe trial.

* A paper read before the Society of Arts, London, March 21, 1882.

* This was only a few years after the sad fate of Franklin's party. If murder had been committed then, would it not probably have been repeated on my three men?

## PROF. HAECKEL IN CEYLON AND INDIA.

PROF. ERNST HAECKEL, of Jena, as most of the readers of *Nature* are doubtless aware, has lately returned to his University after a six months' journey in India and Ceylon, undertaken in the interests of science with the object of providing additional data in support of the theory of evolution, of which he is the most able and best-known exponent in Germany. The veneration which he constantly expresses for Mr. Darwin, of whom he may be said to have been the first and perhaps the chief disciple on the Continent, would of itself suffice to give his opinions and observations weight in this country. No one, however, who has read the series of letters now being contributed by Prof. Haeckel to the *Deutsche Rundschau*, can fail to find them on their own merits both delightful and instructive. They are written in a popular form, but contain traces of profound scientific knowledge combined with great quickness and freshness of observation, and an almost boyish exuberance of delight in the presence of nature's wonders. Of the three letters or articles already published, the first contains an account of the voyage to India, the second, entitled "A Week in Bombay," describes with vivid enthusiasm the caves of Elephanta and the other marvels of that most interesting of tropical cities, and the third, contained in the June number of the *Rundschau*, of which we propose to give a short reproduction for the benefit of our English readers, brings the Professor to the "promised land" of his scientific yearnings—that island of Ceylon which exhibits in all its varied charms "the highest conceivable development of Indian nature."

It was on November 21, 1881, that the Austrian Lloyd steamer Helios, bearing Prof. Haeckel and his numerous chests, some containing scientific instruments, others empty for the reception of specimens, came to an anchor in the harbor of Colombo. He describes in a few graphic words the vision of beauty which met his eager gaze as the morning twilight cleared away, and the island, with its fringe of delicate palm forests, and more thickly wooded interior highlands, crowned in the center by the mysterious summit of Adam's Peak, expanded before him in all the blaze of tropical sunshine. Directly in front lay the fort and harbor, to the right (or south) the beautiful suburb of Colpetty, in which the majority of the Europeans have their residence, and to the left (or north) the Pettah or "Black town," inhabited by the native races. Prof. Haeckel was warmly received on landing by his countryman, Herr Stipperger, the agent of the Austrian Lloyd, in whose bungalow, on the northern side of the town at a considerable distance from the fort, and still farther from Colpetty, he passed the two first weeks of his stay in Colombo, which he describes as among the most delightful of his life. His first drive in Ceylon, from the Fort to Whist Bungalow, through the Pettah, opened out before him, as he himself says, a quick succession of scenes of Eastern beauty. The brown clay huts of the natives, each with its garden of cocoa-nut palms and plantains; the motley population of red-brown Singhalese, and darker Tamils, grouped around the doors, carrying on all their domestic concerns in the open air, combined with the bright red tint of the soil to produce bewildering contrasts of form and color, together with a charming impression of primitive simplicity, and harmony with surrounding nature. It would be impossible to make even a passing mention of the Singhalese and their domestic life without digressing into a description of their most valued and often their only possession, the cocoa-nut,* of whose substance every part is turned by them into account.

### THE PALM TREE.

"The number of cocoa palms on the island," says Prof. Haeckel, "is calculated at 40,000,000, each palm yielding from 80 to 100 nuts (8-10 quarts of oil). It is not found in the northern half of the island, nor on a great part of the eastern coast. Its place is here supplied by the not less useful palmyra plant (*Borassus flabelliformis*). This is the same which covers the hot and dry districts of Hindostan, growing in great profusion near Bombay. Even from a distance the two palms vary greatly. The palmyra is a fan-palm, with a strong, very straight black stem, topped by a thick bunch of fan-shaped leaves. The cocoa, on the other hand, is a feather-palm, its slender white stem, 60 to 80 feet high, is gracefully curved, and adorned with a bushy crown of feathery leaves. The lovely Areca palm (*Areca catechu*) has similar but stiffer and smaller leaves, and a tapering reed-like stem; it is an invariable feature of a Singhalese garden, carefully tended for the sake of the nut, which, being chewed together with the leaf of the betel pepper, colors the teeth and saliva red. Another palm, the Kitool (*Caryota urens*) is cultivated chiefly on account of its abundant sugar-sap, from which palm-sugar (*Djaggeri*) and palm wine (*Toddy*) are prepared. Its stiff strong stem supports a crown of double-feathered leaves resembling those of the maiden-hair fern (*Ad antum capillus Veneris*)."

### THE BREAD FRUIT TREE.

"After the palms the most important trees in the little gardens of the Singhalese are the bread-fruit and the mango. Of the former there are two kinds, the ordinary bread fruit (*Artocarpus incisa*), and the Jak tree (*Artocarpus integrifolia*), growing everywhere in great profusion. Another tree frequently cultivated by the natives is the curious cotton tree (*Bombax*). Mingled with these round the Singhalese huts is the beautiful banana or pisang tree, well deserving the name of "fig of Paradise" (*Musa sapientum*). Its beautiful yellow fruit, affording excellent nourishment either raw or cooked, is here seen in numerous varieties. Magnificent clusters of its gigantic light green leaves, topping a slender stem from 20 to 30 feet high, overhang the Singhalese huts, and form their loveliest adornment. Scarcely less affective are the arrowy leaves of the Aroideæ, especially of the Caladium, cultivated for its esculent roots, the same being the case with the Manibot, with its lovely clusters of hand-shaped leaves (belonging to the Euphorbiaceæ)."

### POPULATION OF CEYLON.

Prof. Haeckel next proceeds to give a short statistical account of the population of Ceylon. In Colombo itself, as well as in the whole southern and western crests of the island (with the exception of the northwest) the large majority of the population consists of Singhalese proper, or descendants of the Indian Hindoos who overran Ceylon in the sixth century B.C., but in the northern half of the island, and on the east coast, as well as in large tracts of the central highlands, the Singhalese have been driven out by the Malabars or Tamils from the southern parts of the Indian peninsula, more especially from the Malabar coast. At present the Tamils comprise about a third of the whole population of Ceylon, and their number is yearly increasing; they are stronger and hardier than the Singhalese, and all the heavier labor falls to their share, the Singhalese only occupying themselves in the lighter kinds of agricultural work. Besides these, there are the Indo-Arabians of Ceylon (called Moormen or Moors), descendants of the Arabs who gained a footing in the island more than two centuries ago. The residue of the native population is composed of the wild aborigines (Veddahs and Rodiyahs) of immigrant tribes from various parts of Asia and Africa, and of Malays, Javanese, Parsees, Afghans, Negroes, and Kaffirs; in all about 25,000. Europeans number altogether only three to four thousand, principally, of course, English and Scotch. The whole of this motley population at the present time may be calculated at 2,500,000, divided as follows:

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|---|---|
| Singhalese (chiefly Buddhists) | 1,500,000 |
| Tamils (or Malabars, chiefly Hindoos) | 820,000 |
| Indo Arabians (Moors, chiefly Mohammedans) | 150,000 |
| Mixed descendants of various races | 10,000 |
| Asiatics and Africans (Malays, Chinese, Kaffirs, Negroes, etc.) | 8,000 |
| Burghers (Portuguese and Dutch half-bloods) | 6,000 |
| Europeans (chiefly English) | 4,000 |
| Veddahs (aborigines) | 2,000 |
| Total | 2,500,000 |

A considerable number of all the native races have been converted to Christianity.

### A COTTAGE AND GARDEN IN CEYLON.

Whist Bungalow, where, as we have already mentioned, Prof. Haeckel spent the earlier part of his stay in Ceylon, received its somewhat curious name from the passionate addiction to card-playing of a former possessor. It is situated on one of the most picturesque spots in the neighborhood of Colombo—that which lies to the north of the fort on the angle between it and the mouth of the river Kalany. Some portions of the description of the site of the bungalow and of his friend's garden must be given in Prof. Haeckel's own words:

"The airy veranda commands a magnificent view of the sea, of the mouth of the Kalany, and of a lovely little island covered with vegetation, which lies in its delta. Further north, the eye follows a long strip of cocoa wood extending along the coast to Negombo. To the south lies the garden of the Bungalow, and beyond it a picturesque plat of land scattered over with fishing huts, nestling under the shade of slender palms; in their midst a little Buddhist temple, and further on a rocky swamp covered with screw pine (*Pandanus*), etc. From this swamp springs a narrow sandy neck of land extending northward to the river's mouth, and so lying as to inclose a peaceful little lake in front of our garden. A few fishing huts are erected on this tongue of land, and from morning to night it presents a constant succession of animated and amusing pictures. Here in the early morning, before sunrise, the inhabitants of the huts assemble to take their morning bath in the river. Then the horses and oxen have their turn, and are brought down to water. Busy washers are at their work all day, beating the clothes with flat stones, and spreading them on the shore to dry. Fishing boats go up and down continually; and in the evening, when they have been drawn up to land, and the great square sails have been spread to dry, the lagoon, with its long row of motionless sails, looks wonderfully picturesque, especially when the evening breeze swells the sails, and the sun, sinking into the sea, floods the whole shore with a radiance of gold, orange, and purple. . . . The garden of Whist Bungalow has been converted, by the care and taste of its proprietor, into a veritable earthly paradise, containing examples of almost every native plant of importance, and thus forming a valuable botanical collection, as well as a fragrant and delightful pleasure garden. On the very first morning of my stay, as I wandered in rapturous delight under the shade of palms and fig trees, bananas and acacias, I gained a very comprehensive idea of the flora of the plains. Here the noble palm, in all its variety of foliage and fruit, rears its stately columns; cocoa and talipat, areca and borassus, caryota and palmyra; here the banana spreads its great feathery leaves to the wind, and displays its clusters of precious golden fruit. As well as various kinds of the common banana (*Musa sapientum*), a fine example of the Traveler's tree of Madagascar may here be seen (*Urania speciosa*). It stands just at the division of the principal walk, from which the path to the right leads to the bungalow, and that to the left brings us to a magnificent specimen of the banyan or sacred fig tree (*Ficus bengalensis*), forming, with its hanging air-roots and numerous stems, a very striking object; beautiful Gothic arches open out among the roots which, pillar-wise, support the main structure of the tree. Other trees of various groups (terminalia, laurels, myrtles, iron-wood trees, bread-fruit, etc.) are over-grown and intertwined with those lovely creeping and climbing plants which play so important a part in the flora of Ceylon. These belong to the most varied families, for in the dense forests of this magic island, and under the favorable influences of moisture and warmth, a countless multitude of climbing plants strive and cling, and grasp their way upward to the light and air.

"Among the charms of this most lovely garden must be included the large-leaved Calla plants or Aroideæ, and the graceful feathery ferns, two groups of plants, which, both by their individual mass and by the beauty and size of their development, occupy an important place in the lower flora of Ceylon. Scattered among them are many of the finest shrubs and flowering plants of the tropics, partly indigenous, partly introduced from other tropical regions, especially from South America, but all perfectly at home here. Among these rises the stately Hibiscus, with great yellow or red flowers, the flame tree or acacia, a mass of splendid flame-colored clusters (*Cæsalpinia*); venerable tamarinds with their aromatic blossoms; while from every branch hang clinging convolvuli with gigantic bell-shaped flowers, and aristolochias, yellow and brown. Rubiaceous plants, such as lilies, orchids, etc., bear extraordinarily large and beautiful blossoms. . . . The animal life inhabiting this garden of Eden does not altogether correspond in variety and abundance with its vegetable world; this is especially the case with its larger and more striking forms. In this respect, as far as I have been able to ascertain, the island is inferior to the Indian mainland and to Sunda Island, and still more so to tropical Africa and Brazil. I must confess that my first impression was one of disappointment, which rather increased than diminished as I came to know the fauna more intimately, even in the wilder parts of the island. I had expected to find the trees and bushes thronged with apes and parrots, and the flowering plants with butterflies and winged insects of curious form and brilliant hue. But my expectations were doomed to remain unfulfilled, and my only consolation was that other zoologists visiting the island had been equally disappointed. Nevertheless, careful search reveals much that is curious and interesting, even to the zoologist, and in its main features the fauna of Ceylon, though not so rich and brilliant, is quite as singular and characteristic as its flora.

"The vertebrate animals which first claimed my attention in Whist Bungalow and the immediate neighborhood of Colombo, were numerous reptiles of brilliant colors and curious forms, especially snakes and grasshoppers, and pretty little tree frogs (*Ixalus*), whose weird, bell-like note, resounded in the evenings. The birds chiefly visiting the gardens are starlings and crows, water-wagtails, and bee-catchers, and above all the pretty little honey-sucker (*Nectarinia*), which here takes the place of the humming-bird; kingfishers and herons abound on the river banks. Among mammalia the most frequently occurring is the pretty little squirrel that leaps about among the trees and shrubs, and is very tame and confiding; its color is a brown-gray, with three white stripes lengthwise down its back (*Sciurus tristriatus*). Among the insects, dense swarms of which abound everywhere, the first to be named are ants (from the minutest to the most gigantic sizes), including the destructive termites or white ant; wasps and bees among the hymenoptera, and gnats and flies among the diptera, are also very abundant. The larger and finer forms of insect life, such as chafers, butterflies, etc., do not exist in any proportion to the flora of the island. Orthoptera (grasshoppers, crickets, etc.), on the other hand, are very varied and curious in form. I will content myself at present with this cursory mention of a subject to which I hope later to return.

"Of articulate animals the spiders (*Arachnidæ*) form a very interesting and curious class, from the minutest mites and ticks upwards to the bird-spinners and scorpions. The closely-allied Millipeds or Myriapodæ are very numerous and of colossal size, sometimes as much as a foot long. I saw one famous specimen on my first morning in the garden of Whist Bungalow, but I was too lost in admiration of the glories of the vegetable kingdom around me to have time for a nearer examination of the animal world."

The energetic Professor was evidently a subject of much wonder to the languid Anglo-Indians and lazy Singhalese, as, in his white linen suit and "Sola" hat, he braved the mid-day sun and even occasionally the tropical rains, besides setting at naught the bites of countless leeches and the stings of mosquitoes and scorpions, and prosecuted his researches from morning till night. It is, however, to this constant bodily exercise and to his invariably temperate diet, that Prof. Haeckel ascribes his perfect health while on the island; but it is doubtful whether, as the body became enervated by the climate, such habits could be long sustained.

### A JUNGLE IN CEYLON.

The first and one of the most delightful excursions made by Prof. Haeckel in Ceylon, consisted in a visit to a Singhalese village called Kaduwella, situated on the left (southern) bank of the Kalany, about ten miles from Colombo. The party from Whist Bungalow, joined by their fellow-countrymen residing at the neighboring Elie House (formerly the residence of Sir J. Emerson Tennent), drove to the appointed place in the little one-horse carriages universal in Ceylon, which are drawn by brisk Burmese ponies, whose speed is superior to their staying powers, ten miles being quite sufficient to tire them out. Horses are rarely used in Ceylon, except in spring carriages, and are almost all imported from the Indian mainland, or from Australia; European horses cannot survive the climate. Bullocks may be said to be the only animals of draught or burden, and Prof. Haeckel mentions the long string of bullock carts, some single, some double, which are constantly met on the road; "the bullocks all belong to the class of the Zebu or humped oxen of India (*Bos indicus*), but there are many varieties; one of the smaller kinds is very swift and agile."*

Prof. Haeckel notes as among the most beautiful effects of the Ceylonese lowlands through which the road to Kaduwella lies, the middle place which they occupy between garden and forest, between cultivated and uncultivated nature. "Surrounded by majestic trees, all overhung and overgrown with creepers and climbers, one might often imagine one's self in the midst of the wildest forest; but a little hut almost hidden beneath a bread-fruit tree, a dog or a pig issuing from the brushwood, children playing hide and seek behind the caladium leaves, serve to remind us that we are in fact in a Ceylonese garden. The real forest, on the other hand, which is closely adjacent, with its manifold juxtaposition of every variety of tropical trees, with its orchids, cloves, lilies, malvaceæ, and other lovely flowering plants, shows all the variety and apparent design of a costly pleasure-garden. This singular mixture of nature and culture is visible also in the human accessories of these forest-gardens; for so great is the simplicity of the dwellings and the clothing of the Singhalese inhabiting them, that although the descendants of an old and cultivated race, there is little in their appearance to distinguish them from mere savages." Arrived at Kaduwella, after a halt and refreshment at the Rest-house (the government substitute for hotels, which are altogether wanting in Ceylon except in the chief towns), Prof. Haeckel made his first attempt to penetrate an Indian jungle, with what success his own words must tell: "The jungle is not, properly speaking, 'primeval forest,' forest, that is, untrodden by the foot of man (such are in Ceylon of small extent and rare occurrence); but it corresponds to our idea of such a forest in that it consists of a dense and impenetrable mass of mighty trees of all kinds, which have sprung up without regularity or any interference from man, and are surrounded and overgrown by a wilderness of creeping and climbing plants, of ferns, orchids, and other parasites, the interstices being so completely filled up with a motley mass of smaller weeds that it is quite impossible to disentangle the coil of tendrils so as to distinguish one species from the other. My first attempt to penetrate such a jungle as this was sufficient to convince me of the impossibility of the undertaking except with the aid of ax and fire. A hard hour's work brought me only a few steps into the thicket, and then I was obliged to acknowledge myself vanquished and make good a retreat, stung by mosquitoes, bitten by ants, with torn clothes, and arms and legs bleeding from the thorns and prickles with which the climbing palm (*Calamus*), the climbing Hibiscus, the Euphorbia, and a multitude of other jungle plants repulse every attack made on their impenetrable labyrinth.

* Sir J. Emerson Tennent ("Ceylon," I., p. 127) mentions, as curiously illustrative of the minute subdivision of property in Ceylon, a case which was decided in the district court of Galle, the subject in dispute being a claim to the 2520th *part of ten cocoa nut trees!*

* A pair of these little bullocks carry up about twenty bushels of rice to the hills, and bring down from fifty to sixty bushels of coffee to Colombo. (Sir J. E. Tennent's "Nat. Hist. of Ceylon," p. 56.

But the attempt had not been made altogether in vain, for it enabled me to gain a very fair idea of the jungle as a whole, more especially of the magnificence of its trees and creepers, besides introducing me to many separate varieties of animal and vegetable life, which were of the highest interest; here I saw the magnificent *Gloriosa superba*, the poisonous climbing lily of Ceylon, with its red and amber flowers; the prickly *Hibiscus radiatus*, with large cup-shaped brimstone-colored flowers, deepening to violet in the hollow; while round them fluttered gigantic black butterflies with blood-red spots on their tail-shaped wings, and chafers and dragon-flies flew past with a metallic gleam. But my delight reached its height when on this, my first attempt to penetrate a jungle in Ceylon, I came across the two most characteristic of its inhabitants from among the higher class of animals—parrots and apes. A flock of green parrots flew screeching from a lofty tree, as they became aware of the gun in my hand, and at the same moment a herd of great black apes sprang with a growling cry into the thicket. I did not succeed in getting a shot at either one or the other; they appeared to be too familiar with the look of a gun. I was consoled, however, by securing with my first shot a colossal lizard or iguana six feet long, of a kind held in much awe by the superstitious natives (*Hydrosaurus salvator*). The huge crocodile-like beast was sunning himself on the edge of a water-tank, and the shot hit him so precisely on the head as to kill him at once; had it struck any less vital part he would probably have dived into the water and disappeared; when seized, the iguana has the power of hitting so sharp a blow with its scaly tail as to cause a severe wound and even sometimes a broken limb."

We regret that want of space forbids us to quote entire Prof. Haeckel's account of a Buddhist temple built on the wooded heights above Kaduwella, and the scene of constant pilgrimages. It was constructed originally out of a natural grotto, the back part of the temple being composed of the bare rock, from which also is hewn the colossal figure of Buddha, which is invariable in all Buddhist temples. Almost as invariable is the adjoining Dagoba, a bell-shaped dome without any opening, containing a relic of Gotama. The size of the dagobas varies from that of a large church bell to the circumference of the dome of St Peter's at Rome. Near the Dagoba is generally to be seen a large Bo-Ga, or sacred fig-tree (*Ficus religiosa*).

"These 'Buddha-trees,' with their venerable stems, fantastic roots, and colossal crown of foliage, form a prominent feature in the picturesque surroundings of the temples; their leaves, which are heart-shaped, with long stalks, quiver like our aspens."

### THE ROYAL BOTANIC GARDEN, CEYLON.

The description given by Prof. Haeckel of the Royal Botanic Garden at Peradenia will be read with interest by all who value the efforts, whether of governments or individuals, to encourage scientific knowledge by placing the means of gaining it within the reach of all. This admirable institution was founded sixty years ago on the site of an ancient royal residence, and placed under the direction of Dr. Gardner. His successor, Dr. Thwaites, the learned compiler of the first "Flora Ceylanica," labored for thirty years to render the garden worthy of its extraordinary advantages of position and climate. On his retirement, a few years ago, Dr. Henry Trimen was appointed director, and from him Prof. Haeckel received a pressing invitation, which all that he had heard and read of Peradenia urged him to accept.

Peradenia is now connected with Kandy, the original capital of Ceylon, by a railway, the first in the island. Prof. Haeckel notes by the way that railway traveling affords the greatest delight to the natives, many of whom make the journey up and down daily for the mere pleasure of the ride! It is the only indulgence on which they are willing to spend their money, and fortunately the line is a cheap one. The journey is of between four and five hours' duration, and the first half of it lies through low lands covered with swampy jungle, alternating with rice fields and swamp meadows. After that, the line begins to ascend, and a constant succession of beautiful mountain landscapes unfold themselves to the view. One of the most magnificent of these is afforded to the traveler at the point called the "Sensation Rock." "Here the line, after passing through several tunnels, runs under projecting cliffs at the edge of a precipice with a sheer descent of 1,200 to 1,400 feet. Roaring waterfalls from the rocky heights on the left are spanned by railway bridges, and, dashing downwards, are dissolved into spray before they reach the foot of the precipice; the sunshine striking them forms them into glittering rainbows. The green valley lying far below our feet is covered partly with jungle, partly with cultivated land scattered over with huts, gardens, and rice-fields, arranged in terraces. Towering above all other trees, rise the giant stems of the majestic Talipat palm, queen of all the palms of Ceylon (*Corypha umbraculifera*). Its perfectly straight white stem resembles a slender marble pillar, and often exceeds 100 feet in height. Each of the fan-shaped leaves which form its stately crown covers a half-circle sixteen feet in diameter; they, like every other part of the tree, are turned to manifold uses, being especially employed for thatching; they formerly provided the Singhalese with a substitute for paper, and are still used in that capacity. The old Puskola manuscripts of the Buddhist monasteries are all written with an iron style upon this "ola" paper, narrow strips of talipat leaves boiled and dried in the sun. The stately talipat palm blooms but once, usually between the fiftieth and eightieth year of its life; the pyramidal clusters of flowers crowning the summit of the palm, reach the length of thirty to forty feet, and are formed of millions of small yellow-white blossoms; when the seed-vessels ripen, the tree dies. By a fortunate chance it happened that an unusual number of talipat palms were in flower during my stay; I counted more than sixty between Rambukhana and Kadugannawa, and more than a hundred during the whole railway journey. Excursions were made from Colombo to witness the rare and beautiful sight."

The following extract gives Prof. Haeckel's first impression of the Botanic Garden of Peradenia:

"The entrance to the Garden is through a noble avenue of india-rubber trees (*Ficus elastica*). The milky sap of this tree thickens into *caoutchouc*. Young plants of it are cultivated in heated rooms of our cold north, for the sake of the decorative beauty of their oval sap-green leaves; but while with us india-rubber plants of six or eight feet high are esteemed a wonder, here in their native land they take rank with the noblest of forest trees, and would rival our oaks in size and strength. A huge crown of many thousand leaves proceeding from horizontal branches 40 to 50 feet long, covers the superficial area of a stately palace, and from the base of its powerful stem rises a network of roots, often between 100 feet and 200 feet in diameter, more than the height of the tree itself. This marvelous mass of roots rises on all sides and twists round the tree in such a manner that the natives have given it the name of the "snake-tree." *

"Scarcely had I recovered from my astonishment at this wonderful avenue of snake trees, when my attention was arrested by a noble group of palms, including nearly all those indigenous to the island, and a number of foreign representatives of this noblest of tropical trees; all festooned with masses of flowering creepers, and adorned with graceful ferns growing at their base. Another similar, but larger and more beautiful group of palms stands at the further end of the avenue. Here the path divides and leads on the left to a little eminence, on which the director's bungalow stands. This charming residence is, like most of the villas of Ceylon, a low one-storied building, surrounded by a veranda, the projecting roof of which is supported by a row of white pillars. ". . The villa stands on the highest point of the garden, which covers an area of 150 acres, and overlooks the noble Mahawelli River, which encircles it on three sides. Its position and climate are unusually favorable for the cultivation of all the wonders of the Ceylon flora.

"In four days spent in Peradenia," says Prof. Haeckel, "I learnt more of the life and nature of the vegetable world than I should have acquired by as many months of close botanical study at home. I can never be grateful enough to my good friend Dr. Trimen for his hospitality and the rich stores of learning which he placed at my service; the days spent in his bungalow were among the most fruitful of my life.

"Another English botanist, Dr. Marshall Ward, was at Peradenia at the same time as myself; he had pursued his studies for the most part in Germany, and bore the official title of 'Royal Cryptogamist.' He had been sent here two years previously by the English government to study the coffee-leaf disease which for many years has raged with increasing violence in the coffee plantations of Ceylon, and has in great measure destroyed this valuable source of revenue to the island. Dr. Ward made many valuable observations and experiments on the natural history of the microscopic fungus, which contains the germ of the disease; but unfortunately he did not succeed in discovering any radical remedy for it. Instead, therefore, of receiving the gratitude due to him for his assiduous labors, he found himself violently taken to task by the press, and especially by the coffee planters. As if the hundreds of European naturalists engaged at the present time in investigating the nature and causes of similar plant epidemics should all be expected to discover a remedy for the disease they are studying! That this is seldom successfully done is a well-established fact, and no axiom is more devoid of truth than that current in what are called 'cultivated circles,' that 'every disease has a cure.'

"It would lead me too far, and would weary my readers to no purpose, were I to attempt a mere verbal description of the botanical paradise of Peradenia; even the drawings and water-color sketches which I there made give a very inadequate idea of its beauties. Unlike most of our botanic gardens in Europe, the plants are not disposed in stiffly laid-out beds, but are arranged with a regard to æsthetic effect as well as to scientific classification. The principal groups of trees and the plants of kindred families are gracefully divided by smooth lawns of turf, and good paths lead from one to the other. In a more retired part of the park are the less attractive and more useful growths of both hemispheres, the seeds, fruit, and shoots of which are distributed among the gardeners and growers of the island. In this way the garden has been for many years of great practical utility as a center of experiments and a garden of acclimatization."

We must conclude our extracts with a suggestion from Prof. Haeckel which seems worthy of notice. He says:

"The singularly favorable climatic and topographical conditions of the Garden of Peradenia would seem to fit it for a wider sphere of scientific usefulness as a botanic station, In the same way that zoological students are now provided with invaluable means of assistance in the prosecution of their studies by the establishment of zoological stations on the sea-coast (at Naples, Roscoff, Brighton, Trieste, etc.) might young botanists in such a botanic station as Peradenia learn and accomplish as much in one year as they would in ten years under less favorable circumstances. Hitherto the tropical zone, the richest of all in materials for study, contains no such institution. If the English Government would establish and maintain a botanic station at Peradenia and a zoological station at Galle, she would add an important item to the services bestowed on science by her Challenger Expedition and other similar scientific undertakings; and she would once more put to shame those States of Continental Europe who can find no more useful or beneficial way of spending their money than in the manufacture of breech-loaders and cannon."—*Nature*.

* "Like snakes in a wild festoon
In famous wrestlings interlaced
A forest Laocoon"
(Hood's Poem of "The Elm Tree.")

## SOME POSSIBLE SOURCES OF ERROR IN COMPUTING THE AGE OF FOSSILS.

IN a paper on the "Limit of the Innuit Tribes on the Alaska Coast," contributed to the *American Naturalist* by Ivan Petroff, the writer gives some evidence that errors in computing geological time, and in reckoning the age of fossils, may be easily made through an imperfect acquaintance with the capabilities of natural forces. Mr. Petroff was compelled to reside for some months in Alaska, in that section where the Innuit and Thlinket tribes meet, and he found a theory that the Innuits are comparatively recent immigrants. An argument in favor of the view that the Innuits spread over the Alaska coast may perhaps be found in the existence of a branch of this tribe on the Aleutian Islands. I fully agree, says Mr. Petroff, with Mr. Dall, that the theory of an Asiatic influx of population over the Aleutian chain of islands is entirely untenable, and that they were peopled from the east, but I do not think that this migration took place before the invention of the kayak. Timber evidently never existed on these islands; the only equivalent being the drift-wood collected along the beaches and promontories; but this kind of material, waterlogged and sodden, was entirely unfit for the manufacture of wooden canoes, or even for the construction of rafts, by which means Mr. Dall supposes the early Aleuts advanced from island to island. The frequency of gales, the violence of currents, and the width of channels between these islands, would also prevent the use of rafts as a means of transportation and traffic. The assumption that the earliest inhabitants of the Aleutian Islands were without a kayak or boat of some kind, is based upon researches in the shell heaps of abandoned village sites on those islands; but a kayak with a whalebone or even a wooden frame, without its modern ornaments of ivory and bone, contained no material that would withstand decay and final absorption. The skin covering, when worn out and unfit for use as such, was, no doubt, then as now, cut up into straps and patches, or served as food in time of famine, while the frame could be utilized in many ways that would leave no trace behind. The mere absence from the lower strata of shell heaps of anything pointing to the existence of the kayak, can scarcely be considered as proof conclusive of its non-existence. My personal observations have led me to believe that the remains of former villages and dwellings found on the Aleutian Islands and on the continental coast of Alaska, are not of the antiquity ascribed to them. Wherever I had the opportunity to observe such localities at long intervals of time, I was astonished at the rapidity with which nature extinguished the traces of man by a growth of sphagnum and other vegetation, giving to the site of the village abandoned but a few years every appearance of great antiquity.

The absence of stone and bone implements of more delicate construction from the lower strata of the shell heaps can easily be attributed to the same cause that explains the absence of iron implements from the upper layers that must have accumulated within historic times. Such articles were the product of much labor, and consequently too precious to be lost. At every successive removal from one dwelling-place to another all such products of their ingenuity were carefully collected and removed by the ancient Aleuts, just as it is done now with regard to iron by the natives of the present day.

On these treeless isles, the removal from one hunting or fishing ground to another of a few families or a community always involved the transportation of every log or plank, and every particle of wood to be found about the place. As an instance of this kind, I may point to the removal of the people of Makushin, on Oonalashka Island, which took place in the early part of the year 1879. In the summer of 1880, I visited the spot from which the people had removed, and found the outlines of every house indicated by a slight depression in the ground, and inclosed by low ridges of earth, covered already with a dense growth of sphagnum and grasses. Every piece of wood about the whole settlement had disappeared simultaneously with the people; and I have no doubt that an explorer unacquainted with the circumstances could dig up these remains without finding a scrap of iron, or anything indicating their recent occupation by at least a semi-civilized people. Another example of this kind, and even more forcible in total absorption of all signs of recent occupation, can be found on the island of Atkha, at the site of the former settlement of Korovinsky, the people of which removed to Nazan on the other side of the island less than fifteen years ago.

In the settlements remote from the trading centers the people of Innuit stock live to day as they did probably centuries ago, in a manner not at all inconsistent with the remains found in the lower strata of shell heaps. Even the presence of stone and bone arrow and spear heads is no true indication of age, as they are manufactured at the present day, as I had an opportunity to witness frequently during my travels in remote regions.

The time required for the formation of a so-called layer of "kitchen refuse" found under the sites of Aleutian or Innuit dwellings, I am also inclined to think less than indicated by Mr. Dall's calculations. Anybody who has watched a healthy Innuit family in the process of making a meal on the luscious echinus or sea-urchin, would naturally imagine that in the course of a month they might pile up a great quantity of spinous debris. Both hands are kept busy conveying the sea-fruit to the capacious mouth; with a skillful combined action of teeth and tongue, the shell is cracked, the rich contents extracted, and the former falls rattling to the ground in a continuous shower of fragments until the meal is concluded. A family of three or four adults, and perhaps an equal number of children, will leave behind them a shell monument of their voracity a foot or eighteen inches in height after a single meal. In localities in Prince William Sound, I had an opportunity to examine the camp-sites of sea-otter hunters on the coast contiguous to their hunting grounds. Here they live almost exclusively upon echinus, clams, and mussels, which are consumed raw in order to avoid building fires and making smoke, and thereby driving the sensitive sea-otter from the vicinity. The heaps of refuse created under such circumstances during a single season were truly astonishing in size. They will surely mislead the ingenious calculator of the antiquities of shell heaps a thousand years hence.

On the coast of Cook's inlet I have observed other instances of the rapid transformation of dwelling sites.

In the year 1869 I erected a substantial log-house in the vicinity of the village of Chkituk. I visited the spot last summer and discovered nothing but faint lines of the foundation of my house indicated by low ridges overgrown with mosses and grasses, and two young spruce trees growing up from the spot where my fireplace had been located. In the same locality, at the mouth of the Kaknu or Kenai River, the remains of the first log building erected there by the Russians in 1789 can now be seen protruding from the almost perpendicular river bank 15 ft. or 20 ft. under the present surface.

As an instance of the rapidity with which the tides of this region will change outlines of coast and other landmarks, I may cite an observation made by me during my stay on Nuchek Island last summer. At a short distance from the settlement there was a cave in a rocky cliff situated about three or four feet above high-water mark. I visited the place frequently, as it afforded a view over the approaches to the harbor. About the middle of June an eclipse of the moon occurred when it was full or nearly so, causing tidal commotion of unusual extent and violence. When I visited my cave on the day following the eclipse, I found it almost filled with shingles and debris. This cave was situated at about the same height above the water as the cave of Amaknak, from which Mr. Dall extracted such voluminous information as to the antiquity of strata of refuse found therein. I cite these instances only for the purpose of showing that it is not safe to ascribe great age to any and all accumulations of debris found on the coast of Alaska, and also as a support for my theory of a general Innuit migration along the coast at a comparatively recent period, subsequent to the invention of the kayak or a similar structure.

WHEN, says the *Polyt. Notizblatt*, a few drops of ether or alcohol are let fall upon a paper equally moistened with cadmium and iodide starch solution, and the volatile liquids are set on fire, the paper will be found, after their evaporation, to be turned blue, owing to the formation of ozone.

## THE GASTORNIS.

MR. GASTON PLANTÉ, who is so well-known for his labors in connection with electricity, had the good fortune in 1855 to make a discovery in paleontology that was somewhat remarkable. A very curious clayey stratum, which has now nearly disappeared, and which is known as the Meudon ossiferous conglomerate, yielded him in the above-named year a bird's tibia, which, although incomplete, measured 45 centimeters in length. At first sight, this gigantic bone presents a great analogy with the corresponding one of the swan, and differs from that only in the presence of a sub-trochlean fossa, and in the relatively high situation of the osseous arch and external muscular attachment. But what a contrast as to size! We represent, a little further along (Fig. 2), on the same scale, the tibia of the Meudon bird, which Constant Prevost has justly named *Gastornis* (Gaston bird), and the tibia of the common swan.

Since the epoch of Mr. Planté's splendid discovery, a geological formation exactly corresponding to the Meudon conglomerate has been found in the neighborhood of Rheims. Very recently, Dr. Lemoine has drawn the bonds that united these two formations still more closely, by the discovery in Champagne of the remains of another *Gastornis*—a new species of the genus to which has been given the name of *G. edwardsii*. This specimen was not less than three meters in height when it stood upright, and it is shown in this position in Fig. 1. The discoverer has in his possession the femur, the tibia, the tarso-metatarsal bones, and the phalanges. The pelvis is represented in his collection by an ischion and the upper extremity of the pubis. A cervical and a caudal vertebra, a fragment of the sternum, and a few rib extremities have furnished him some very interesting observations. He has also collected some pieces of bone which he considers as a coracoid bone and half of the clavicle; and besides these, the lower extremity of the humerus, a radius, a metacarpal bone, and the terminal phalanx of the wing. Finally, Dr. Lemoine has discovered, during his paleontological excavations, a large portion of the bones of the head, which have allowed him to make his description of this so peculiar an ornithological type much completer.

In Fig. 1 are grouped together in their natural position all the parts of the skeleton that have thus far been detected.

This wealth of material has given Dr. Lemoine very accurate ideas in regard to the gigantic bird of the environs of Rheims. According to him,* the cranium must have been relatively large, and less disproportionate than that of the ostrich, as is shown by the os quadratum, a part of the orbital cavity, and almost the whole of the base of the cranium, which exhibits the occipital condyle, the subcondyle fossa, the basilar processes, and the basipterygoidal apophyses. According to Mr. Huxley this character is met with at present in various birds, such as tinamous, divers, ducks, chickens, and in different lacertians and ophidians.

The upper mandible, which was found nearly entire, is very remarkable for a series of pseudo-alveoli, putting one in mind of the atrophied alveoli of reptiles, and corresponding, not to true teeth, but to a thickening of the horny material of the bill. The latter, however, toward its anterior, exhibits a true tooth, but of a bony nature and continuous with the substance of the bill itself. As well known, this kind of dentition has been observed by Richard Owen in *Odontopteryx toliapica*.

The lower mandible is known by its terminal extremity, which must have been pointed, and by its posterior half presenting attachments for the muscles, although these are not very prominent.

* "*Recherches sur les oiseaux fossiles.*"

The portion of the sternum found does not allow us to say whether or not this portion of the skeleton was keeled. The shoulder seems to have been composed of quite a short fourchette of wide posterior articular surface, of a coracoid bone, and of a scapula, isolated and quite different from the single osseous piece that is met with in the ostrich. The humerus, as well as the other bones of the wing, is larger than in the ostrich; while the cubitus reminds one more of the form of that bone as found in ordinary birds, and exhibits impressions that indicate the feathers. The radius is slender; and the metacarpals appear to have been independent—a character of the greatest value, since it is met with only in the Sauuræ and Archæopterygidæ. The iliac bone, which is very distinct, is remarkable for the sloping cut that it presents on its posterior edge.

In the presence of characters such as these, it is very difficult to find the affinities of *Gastornis*. Messrs. Hebert, Lartch, and Owen have given their views in regard to this, and the latter is inclined to put the fossil bird in the order of the Grallatores, or waders. Mr. Alph. Milne Edwards, on the contrary, states that the *Gastornis*, unlike the latter, does not exhibit the deep groove in the tibia, which is often even covered with an osseous arch, and which is designed to hold the tendon of the inferior peroneal muscles. Taking the different osteological characters into consideration, Mr. Edwards is rather inclined to consider the *Gastornis* as related to the ducks, although he states that the eocene animal presents peculiarities that are so different from anything found in our existing birds that it is impossible to relegate the fossil to any of the natural groups that are at present established.

It is important to add that the *Gastornis edwardsii* does not represent the sole ornithological fauna of first tertiary times; for, in addition to another *Gastornis*, which Dr. Lemoine well describes under the name of *G. minor*, he has collected the remains of two entirely different genera of birds. These the indefatigable paleontologist designates as *Remiornis heberti* and *Eupterornis remensis*, but as yet he has not published their characters.

The formation about Rheims contains not only these remains of birds, but also those of a numerous series of mammals, among which we may cite: *Artœcyon gervaisii* and *A. dueilii*; *Proviverra palæonictides*; and several species of *Pleniadapis*, *Pleurarpidotherium*, *Lophiodon*, and *Plagiaulax*. Besides this, there are reptiles and fishes, the exhumation of which has proved one of the most valuable acquisitions that the history of the tertiary formation has made in recent times.

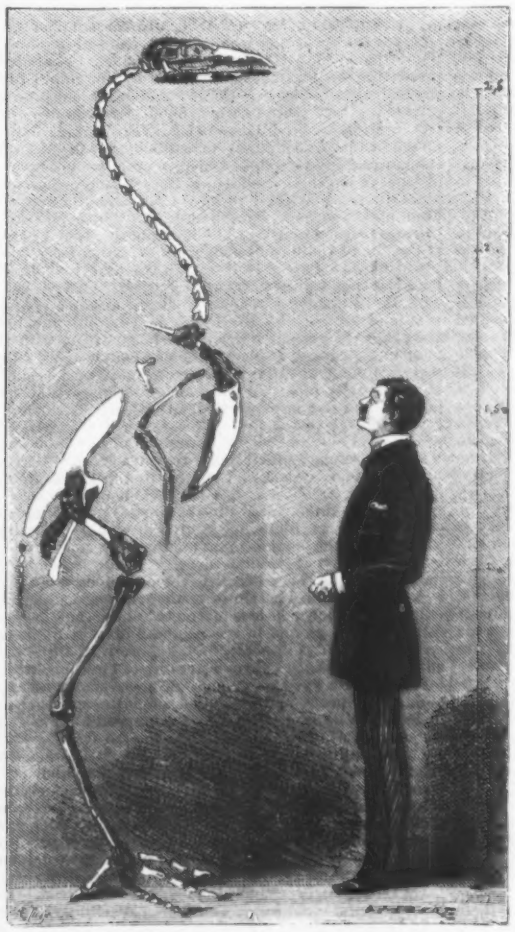


FIG. 1.—RESTORATION OF THE SKELETON OF GASTORNIS EDWARDSII.

FIG. 2.—A, tibia of Gastornis, 1/5 natural size. B, tibia of the Swan, 1/5 natural size.

## NUT-BEARING TREES.

By JAMES DOUGALL, Windsor, Ontario.

As you have advocated, from time to time, the planting of nut-bearing trees in places where the land is not suitable or not intended for cultivation, and as there has been some inquiry through your columns regarding the proper time and way to plant and cultivate them, I give you my experience on the subject.

THE BLACK WALNUT (*Juglans nigra*), owing to its gigantic size, its beautiful and graceful appearance when at maturity, its quick growth, and the great value of its wood in a commercial point of view, besides its value as a nut-bearing tree, is first of its class. It is in every way suitable for road, lawn, or grove planting, where the soil is suitable, but I doubt if it could be grown to advantage on rocky or barren lands unfit for cultivation, as it requires a rich, deep soil. It grows naturally to an immense size on the rich lands of the western peninsula of Ontario, in Ohio, and other States. In 1853 I planted a row of one-year-old black walnuts. No after care was taken of them. The greater part, including the largest, were cut down to make room for buildings. On examination I find only four of them left, the largest of which measures four feet in circumference at the butt, three feet six inches at six feet high, and three feet at fifteen feet from the ground, and upward of forty feet high; the other three trees are about an eighth less in size. Had the nuts been planted where the trees were to stand, and had they not been injured by buildings so near them, they would probably have been much larger.

THE BUTTERNUT (*Juglans cinerea*) is not so large or so valuable a tree as the black walnut, but it will grow in places where the other will not thrive, and grows naturally much further North. I have seen it growing to a good size on the stony sides of the Montreal Mountain, and it would no doubt do well in places unfit for general cultivation. The wood is not so valuable, but the nuts are preferred for eating to the black walnut, though both are rather strong and cathartic. Both are nearly as good for pickling when gathered green, as the European walnut.

THE EUROPEAN WALNUT OF MADEIRA NUT (*Juglans regia*), where the climate and soil are suitable, would be a valuable tree to plant, but it is too tender for this section of the country. I have tried it largely, but it is invariably winter-killed to within a foot or so of the ground, sending up strong shoots from the base the following season, to be again killed down the following winter. My soil is a strong clay loam. If planted on a light soil, with gravelly subsoil, it would perhaps stand the winter here, and further south it would no doubt succeed well and prove profitable for the nuts as well as for the wood.

THE HICKORY, shell bark (*Carya alba*), is only second in value to the black walnut, if it is not really first. The wood is very valuable, being much used in carriage building and for other purposes, while as a wood for fuel it stands first. The nut, with perhaps the exception of the sweet chestnut, is the most prized of any of the nut-bearing trees of this country, and always commands a steady sale and high price, which will continue to increase as the trees in the forests get scarcer, large numbers being cut down for firewood everywhere.

In clearing a farm for pasturage some years ago I left all the hickory-trees, of which there were a great many, some of them of very large size. I found great differences in the size and quality of the nuts. Some were very large, with very thick shells and but little meat in them, others nearly as large, with comparatively thin shells full of meat of a finer flavor, while others bore small or medium-sized nuts of inferior value.

The hickory, from its upright, graceful habit, its quick growth and valuable qualities, is one particularly suited for roadside, lawn, or grove planting. It requires a similar rich soil to the black walnut, or rocky hillocks with good soil among the stones, on which it will attain a large size, bearing early, and will prove very profitable to those who plant it largely. The nut must be planted where the tree is to stand, as owing to its large tap-root it will not stand transplanting from a seed-bed, as I have found by experience.

THE PECAN (*Carya olivæformis*) is a variety of the hickory, with oblong-shaped nuts, a thin shell, and more delicate flavor. I have not heard of its being grown to any extent in the Northern States, its natural habitation being further south; but I have no doubt it would grow well wherever the hickory grows. It is equally hardy here, and grows fully as fast and strong as the hickory. Some years ago I planted some of the nuts in my garden in the fall. They grew the following spring, but being too close together I removed all but one and planted elsewhere. Like the hickory they did not stand transplanting, and dwindled away. The one left grew very fast till it attained two feet in circumference, when it suddenly blighted just as it was coming into bearing and died back. Supposing it had been injured by the winter, or unsuitable to the climate, I thought it would not succeed so far North, but I afterwards found that my neighbor had placed a number of barrels of coal oil against my fence, which had leaked so much that two years after in digging I found the subsoil perfectly saturated with the oil. This had killed the roots of the tree on that side. On cutting back the tree to a shoot on the sound side it has since grown fifteen feet, and bids fair to become a good-sized tree. The pecan is well adapted for a shade tree or for planting for profit.

THE SWEET CHESTNUT (*Castanea vesca*), is one of our large and handsomest trees, and is very profitable when grown on suitable soil. It is very prolific—the nuts, which are easily gathered, falling to the ground when ripe, and selling at high prices in any quantity. It will only grow on light, sandy soils, with gravelly subsoil where it attains an immense size. A friend made as much from a fine grove of gigantic trees near his house as he did from the rest of his farm of fifty acres. His trees were near enough to overshadow the ground so that grass would not grow, and he kept it clean and smooth, so that the nuts could be gathered once or twice a day, as they fell. The timber is also valuable and very lasting.

THE EUROPEAN OR SPANISH CHESTNUT is said to be the same as the American, but larger fruited. It has been greatly improved by cultivation, and is now nearly as large as a small horse-chestnut, but is not so sweet or fine flavored as the common American variety. In Spain, the southern parts of France, Italy, and the adjacent counties, sweet chestnuts, either raw, boiled or roasted, or ground into flour, form a common article of diet. It is not, however, the wild chestnut which furnishes the nuts that are consumed in the south of Europe and exported to more northern countries, but a number of cultivated varieties, the nuts of which are larger and sweeter.

I formerly imported a large number of trees of the best of these varieties from France, but they were too tender for this climate, and died off in a few years. This may, however, be attributed to unsuitable soil, and I presume that planted on soil in which the common chestnut thrives, they would stand our winters. Farther south, on land, as previously described, they would no doubt do well and prove highly profitable; while in the light, sandy soil best suitable for it other crops do not prove profitable.

THE ALMOND (*Amygdalus communis*) will do well in many parts of the United States, wherever the peach grows and the seasons are long enough to bring its fruit to maturity. I have grown the hard-shell variety in perfection here, but I have not heard of orchards being planted with it, though it would prove highly profitable in the Southern States or California; and it could be grown in place of peaches where the latter would be too far from a market. Its cultivation is the same as the peach, to which it is nearly allied. In France the peach is commonly budded on the common almond, being considered more hardy. There are several varieties, the *common*, the *hard-shell sweet*, the *soft-shell sweet*, and the *bitter* almond. The *soft-shell sweet* ripens much earlier than the other varieties, but is rather tender north of Phila-

delphia. As the nuts imported from Europe are often stale and musty, there is no reason why all that are required in this country should not be grown in it, so as to have them always fresh and sweet.

The cultivation of nut-bearing trees is very simple when understood. As a general thing they will succeed much better if the nuts are planted as soon as ripe in the fall where they are to stand. The greater part of them have very large tap-roots which have to be cut off short in removing them, so that they do not thrive or even grow, as before mentioned, when transplanted.

Two or three nuts should be planted in a hill, the best only being allowed to grow. The great difficulty in planting in this manner on waste lands which are usually used as pasturage will be to keep the cattle from browsing them till they are high enough and large enough to be out of danger. A few stakes driven in around them and wattled with thorn branches is an excellent protection, and a space round each tree wherein grass should be hoed for some years.

When planted as orchard or groves it would be advisable to keep the land planted with corn or hoed crops. Thick planting is advisable to be thinned out by degrees to the proper distance. The thinnings of the hickories more especially would sell well and pay for the cultivation till the trees begin to bear.

After procuring the nuts in the fall they should not be allowed to dry or shrivel in the least. If not convenient to plant at once where they are to stand, they should be mixed with sand or light mould in a box or barrel and exposed to the freezing and thawing of winter, to be planted out the first thing in spring, as is usually done with peach stones.

Windsor Nurseries, Ont., Canada.

## HOTHOUSE MELONS AND CUCUMBERS.

WE received from Mr. John Coysh, The Gardens, Newbold Revel, Rugby, a photograph, from which the annexed illustration was prepared, accompanied by the following remarks: "At this establishment for several years I have practiced with success, growing melons and cucumbers in the same house, and the photograph I send will help to show that this plan is worthy of a trial. The house being too large for melons alone, where a small but regular supply is required, I determined to try the two fruits together, and this year, in February, on one side ten melon plants were planted, and on the other, six cucumbers. The melons have borne forty-five fruits, all of a good size. They began to ripen on May 18, and all were ripe in a few days afterward, when the house was cleared and planted as before.—*The Gardener's Chronicle.*

---

COFFEE IN TYPHOID FEVER.—Dr. Guillasse, of the French Navy, reports that, in the early stages of the disease, coffee is almost a specific against typhoid fever. He gives to adults two or three tablespoonfuls of strong black coffee every two hours, alternating with one or two teaspoonfuls of claret or Burgundy wine. The beneficial effect is immediate. A little lemonade or citrate of magnesia should be given daily, and after a while quinine.

## HOW TO TELL THE DISTANCE OF THE SUN.—THE TRANSIT OF VENUS, DECEMBER 6, 1882.

By EDGAR L. LARKIN.

### RUDIMENTARY PRINCIPLES.

IF we divide a semicircle by its radius the quotient will be 3·1415926535. But in a semi-circumference there are:

| | | |
|---|---|---|
| 180 Deg., | divided by 3·1415926535 = | 57·2957795139 |
| 10,800 Min., | " " " = | 3,437·74677 |
| 648,000 Sec., | " " " = | 206,264·80625 |

That is, a radius of any circle contains in terms of the circumference in round numbers 57 degrees, 3,437 minutes, or 206,264 seconds. These are among the most important numbers known to mathematicians, and should be committed to memory by all who would learn astronomy or know how celestial measurements are determined. Let us examine this matter closely. Take a ball one foot in diameter, place it on a standard in front of a telescope provided with a micrometer, and the globe will subtend a certain number of degrees angular measurement, which, let us assume, is four degrees. Now move the standard on a right line away from the telescope, and soon the sphere will only subtend three degrees, then two degrees, until finally its distance becomes so great that its angular diameter shrinks to one degree. An important circumstance follows—we know that the ball is precisely 57·295795139 feet distant from the focus of the objective, because we have seen that radius contain that many circular units. Again, move the standard until the angular diameter of the ball shrinks to one minute, and it is at once known that the globe is distant 3,437·73677 feet. Still bear the sphere away until its diameter subtends one second, a space only visible in a powerful telescope, and we likewise know that the ball is in distance 206,264·80625 feet or 39·0653 miles.

This is the process of measuring the distance of an object when its linear diameter is known. To reverse the case, we will suppose that we have a globe whose diameter is one foot placed on a standard. Let an observer with a telescope retire and view the ball at a distance, and telephone to an assistant at the sphere its angular diameter. Then the party at the standard can tell the distance of the telescope. If the message received is: the apparent diameter is one minute, of course the distance traversed is 3,437 feet; if two minutes, half that distance. But to avoid calculation, sines, cosines and tangents of all angles are made use of to abridge the work. If we divide:

| | | | |
|---|---|---|---|
| 3·1415926535 | by | 180 | the quotient is 0·0174532925 |
| 3·1415926535 | " | 10,800 | " " " 0·0002908820867 |
| 3·1415926535 | " | 648,000 | " " " 0·00000484813681 |

which decimals are ratios of the units of the circumference in terms of the radius, for degree, minute and second respectively, and are termed sines. To determine distances, all that is necessary is to use the sines in simple multiplication and division. Thus, the diameter of the ball is one foot, and since the observer saw it as one minute, we divide 1 by 0·00029088820867, having for a quotient 3437·74677 feet distance.

### THE DISTANCE OF THE SUN.

If the Sun subtended an angle of one second, we have seen how many times greater its distance would be than its diameter, but the actual angular diameter of the Sun as obtained by many measures is 1,924 seconds. Therefore, 296,264·80625 divided by 1,924, equals 107·20624, which we positively know is the number of times the distance of the Sun exceeds its diameter. But this gives us no clew to the distance in miles, because we have not yet learned the diameter of the Sun in miles. We know its angular diameter to be 1,924 seconds of arc, whence it is clear that if the number of miles in one second is known, the diameter of the Sun in miles and its distance can be told by simple arithmetic.

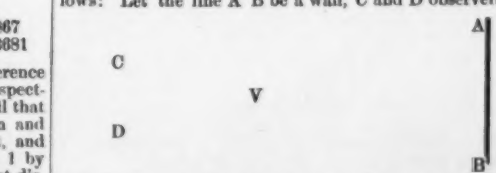
But men have been striving for 2,000 years to find the linear value of one second at the Sun's distance. Really it is the greatest problem ever undertaken by the human mind, it has become of world-wide importance, while the nations of earth have taken up the question, organizing expeditions to send to the bounds of the world. As we write, every civilized people is making up parties to journey throughout the earth to make accurate measurement of the transit of Venus across the solar disk on December 6, next.

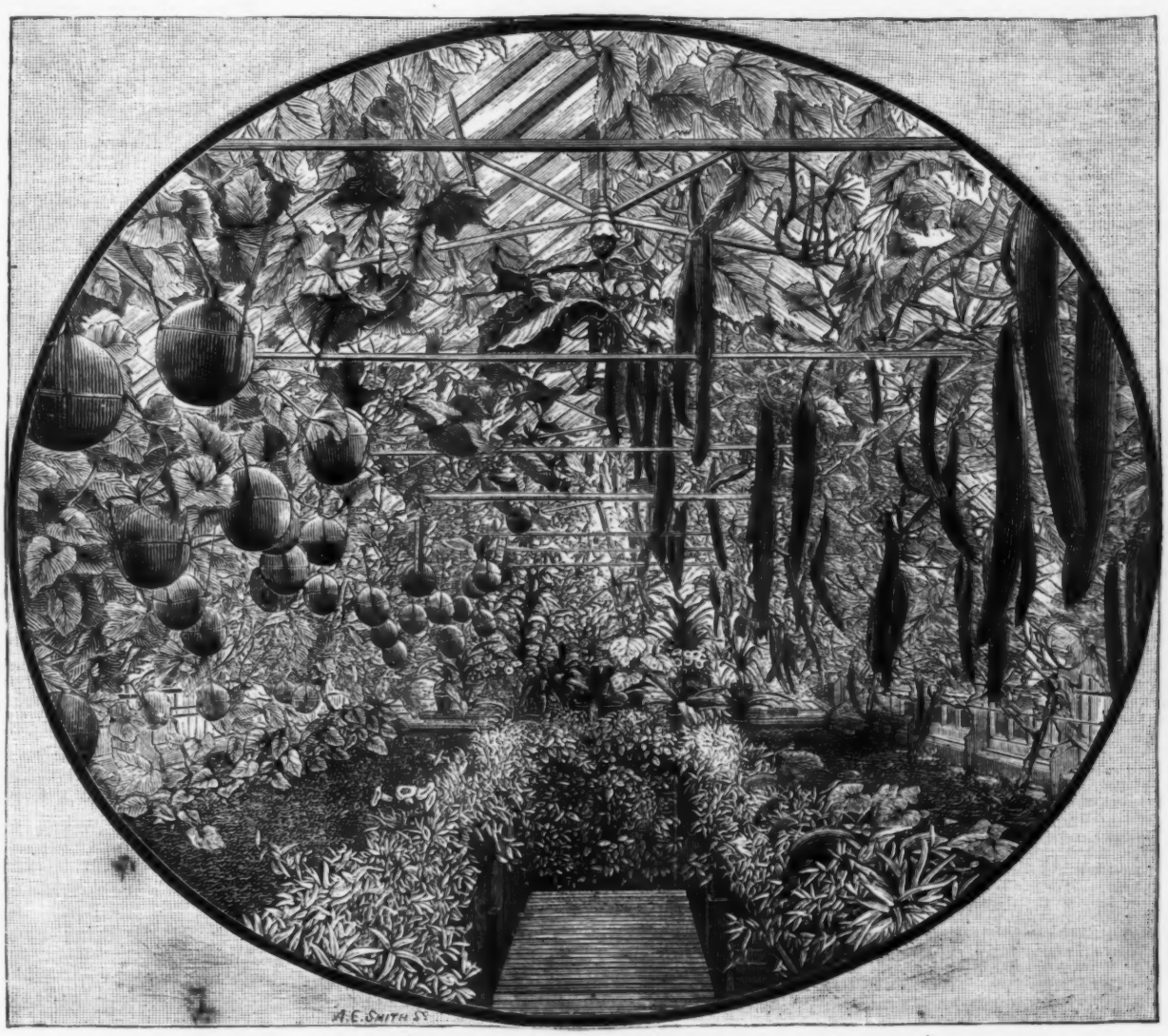
Forty expeditions are already announced, while those contemplated by the United States, Italy and Austria have not yet been published. France will send out eight fully equipped parties, four south and four north of the Equator. The United States will have six groups of astronomers in the central line of the transit, while all the permanent observatories in the country will make close watch of the phenomenon. The occasion is worthy the combined effort of mankind, because as soon as the precise distance of the Sun is known, the dimensions of the universe become known, for the solar distance is the measuring line used by astronomers to let fall in unheard of solitudes of space.

### THE TRANSIT OF VENUS.

The sole object in measuring the displacement on the solar disk of the planet Venus in transit is to find the number of miles in one second of angular measure at the distance of the Sun.

In other words, how large does the earth look if seen by an observer standing on the Sun, and what is its apparent angular diameter? The diameter of the earth in miles is known with great precision, the probable error being within 200 feet. It is self-evident that if it can be ascertained how great an angle the radius of the earth subtends, if viewed from the Sun, we shall at once know the value of one second of arc in miles. The method made use of is as follows: Let the line A B be a wall, C and D observers having telescopes, and V a ball resting on a support. Now let




MELONS AND CUCUMBERS IN THE SAME HOUSE.

C rest his glass on V, and he will see it in apparent projection on the wall at B, while D will see V at A.

But the distance from C to D is known, therefore the distance from C and D to V and to the wall can be told in feet, providing we know the *relative* distance.

The relative distances between the Sun and planets have been known since the time of Kepler, while the real distance is what men are now searching after with enthusiasm. The relative distances of the planets from the Sun and from each other are found by measuring the angles described in a specified time by the exterior planets at times of opposition, and those of interior by the angles presented at elongations. For two centuries it has been known that if we call the distance from the earth to the Sun 1, that of Venus is 0·723; then the distance of Venus from the earth is of course 0·277. Now in the diagram the wall is the Sun, V Venus, C an observatory on one side of the earth, and D another on the opposite, near as can be. And it is endeavored to have C and D at the extremities of a diameter of the earth that is perpendicular to the plane of the ecliptic. As the latitude and longitude of C and D are known, the arc of the great circle a circumference of the earth passing through them being interrupted thereby, is known. Having the arc we know its chord in miles, which is none other than the straight line through the earth, joining each station. The first step of each party on arriving at their destination is to find their precise latitude by direct observation on fixed stars. Then the longitude is determined by chronometers, in conjunction with transits of fundamental stars. At length the eventful moment arrives, the instruments are all in adjustment, and Venus, a black ball, just cuts off a ray of light from the eastern limb of the Sun. The absolute instant of contact in Greenwich time is noted and recorded, the exact point of ingress on the solar edge, measured from the north point, is also recorded, and the transit progresses. This same observation is made from all the stations, accurate results being saved at each for reference.

The precise time of disappearance of Venus from the western limb is also noted, as well as the exact point of departure. Upon reaching home the results are compared. Those observers who were stationed south of the earth's equator will all bring in reports saying that they saw Venus make ingress and egress at points further north on the solar disk than did those remaining at observatories in north latitude.

Thus: if an astronomer at Washington compares notes with the one who went to Santiago, he will find that the southern observer has record of contacts at points farther toward the north point of the Sun than he has. Since these places of contact are accurately measured, the distance asunder of the chords A and B becomes known in seconds of arc. Venus appears to all observers, whether north or south of the equator, to traverse straight lines from east to west across the Sun, but these lines are chords of arcs whose sines are found in any table. But the space between the chords corresponds to a known difference in position of observers on the earth, depending directly on the length of the straight line through the earth connecting any two observing stations. Then:

0·277 : 0·723 : : 1 : 2·61.

That is, the ratio of the distance of Venus from the earth is to its distance from the Sun as 1 to 2·61. Hence the space between the chords on the Sun is to space between two stations on the earth in the same ratio, or as 2 61 is to 1. In other words, the distance apart of the chords is 2·61 times greater than the diameter of the earth. What we are searching for is the mean equatorial horizontal parallax of the Sun, or, what is the same thing, the angle that would be subtended by the mean equatorial radius of the earth if viewed by a micrometer placed on the Sun. Radii drawn from all the observing stations to the center of the earth of course are not equatorial, since observers are placed in all latitudes, hence they must be expressed in terms of equatorial radii by computation.

Again, the mean distance of the earth from the Sun is equal to 1; but at the time of the last transit, December 9, 1874, and at the next, December 6, 1882, the earth was not, and will not be, at mean distance; being near perihelion, with distance less than unity. And due allowance must be made for this fact in calculating parallax, also an allowance must be noted arising from the motions of the earth and Venus during the time of transit, which complicate matters, making it necessary to introduce algebraic formulas wholly inconsistent with a note like this, only intended to give general ideas. However, when all corrections are made, it is found that at transits of Venus under refined micrometrical manipulation, the space between the chords on the solar disk, corresponding to a distance on the earth equal to its mean equatorial radius, is 22·96 seconds of arc. But we have seen that this is 2·61 times greater than the line that would be subtended by the semi-diameter of the earth at the same distance. Whence 22·96 divided by 2·16 equals 8·8 seconds, the long-sought number, the *parallax* of the *Sun*. That is, if we stand on the Sun and look this way with a powerful telescope and micrometer, the earth will appear as a little ball whose radius subtends an angle of only 8·8 seconds.

Now, since the mean equatorial radius of the earth is known to be 3,962·72 miles, we are nearing the end of a search kept up for centuries, and will soon know the value of one second in miles, at the earth's distance from the Sun. Dividing 3,962·72 by 8·8 gives a quotient of 450·30909, the number of miles in one second of arc subtended on the circumference of a circle whose radius is the distance separating the earth and Sun

But we saw that the sine of 1 second is 0·00000484813681, which multiplied by 8·8 equals 0·000042663603928, the sine of 8·8 seconds, since the sines of minute arcs vary directly with the arcs themselves.

In any triangle the sides are in the ratio of the sines of opposite angles; therefore 3,962·72 divided by 0·000042663603928 equals 92,882,917, the number of miles from the center of the earth to the center of the Sun. Or the result may be thus obtained: 1 divided by 0·000042663603928 equals 23,439·18253337, which is the number of times the distance of the Sun is greater than the mean equatorial semi-diameter of the earth, and being multiplied by 3,962·72 gives 92,882,917, as before. If this is not clear to beginners, the case may be presented in a still more elementary form. For when we know the value of 1 second, the circumference can be found by multiplying the value by the number of seconds in a circle. Thus: 450·30909 multiplied by 1,296,000 equals 583,600,580 miles in the orbit of the earth, which divided by 6·283185307, the ratio of a circumference to its radius, gives as in other methods—92,882,917.

It may be asked, since we know the distance of the Sun, why send expeditions to observe the coming transit? The answer is, the precise parallax is not known, it being still uncertain within a few hundredths of a second. We do not know whether it is 8·79, 8·8 or 8·81 seconds. The rays of the Sun beat the atmosphere of the earth and produce a tremulous motion in the focus of a telescope just where the micrometer is, and another trouble is that Venus has an atmosphere which refracts a ray of light somewhat rendering uncertain the exact instant of contact with the solar limb. And it is to determine these corrections to the last transit, and also to verify the measures of 1874 with improved instruments, that so much time, labor and skill are to be expended. And there is also a higher aim than this, and that is to leave to future astronomers who will behold the next transit, June 8, 2004, all the data possible for the mathematically exact determination of the great problem.

One method of observing the transit is to photograph Venus while on the Sun and then make computation at leisure—a method radically different from that of measuring directly with a micrometer at the time of transit.

A brisk controversy is now being held by astronomers as to which plan has the least objections, the apparent majority as the case now stands being opposed to photography. The British photographic results were conflicting in 1874, the deductions being: Airy, 8·79; Tupman, 8·81, and Stone, 8·88. Other values deduced by direct measures range from 8·78 to 8·84 seconds. From a careful comparison of all available records of the problem, the writer is convinced that the parallax of the Sun is 8·8 seconds.

There are a number of ways of determining this constant in nature without resorting to transits of Venus, the most important being based on the velocity of light and the law of gravity. And these confirm the best results of transits in placing the parallax at 8·8.

This is the most valuable number known to man, since it enables him to measure the distances, diameters, volumes, weights and densities of all bodies in the solar system; and, when he has weighed all these, to soar away into the infinitude of space and weigh other suns than ours and tell their distances.

In conclusion we will endeavor to show with what refinement measurement is expected to be made next December.

Thus: by taking the parallax to be 8·8 seconds, the distance of the Sun becomes 92,882,917 miles. Now, if we assume it to be 8·81, then the Sun's distance will be 92,777,488 miles, or 105,429 miles nearer, that is, a hundredth of a second of parallax equals 105,429 miles in the length of a line reaching from the earth to the Sun. But the hundredth of a second is the equivalent to the angle subtended by the diameter of a hair placed at a distance of 800 feet. Young, "The Sun," p. 28.

The observers must have micrometers delicate enough to measure these excessively minute distances with precision, or we shall not derive benefit from the transit. However, the Clarks with their elegant telescopes and micrometers will prove equal to the occasion. Such precision would not be necessary were it not for the fact that the distance to the Sun is the line that is made use of to measure all others in celestial space. And even an error of 100,000 miles would not be of such moment if we used the solar distance but once in a calculation. But in most physical researches, it is involved in the ratio of its cube. Thus, if we raise, for instance, 3 to its cube we have 27, but if we raise 3·25 to a cube the product is 34·328, an error far too large to be admitted. It is seen then that the minute error of 100,000 miles when cubed becomes formidable.

Thus, we cannot tell the distance of Jupiter, nor its weight, size or density, unless we know just how far it is from the earth to the Sun. Kepler's third Law says: That the squares of the times of revolution of all the planets are in the ratio of the cubes of their mean distances from the Sun. We can all see how long it takes Jupiter to go around the Sun; then all we have to do is to square this time and extract the cube root, and we have its mean distance. Thus: the earth revolves around the Sun in a time equal to 1; and we observe that Jupiter makes circuit in a period equal to 11·86. The square of 11·86 is 140·66, whose cube root is 5·203; hence we are assured that whatever is the distance of the earth from the Sun, that of Jupiter is 5·203 times greater. Knowing its distance, its mass and volume are revealed by the law of attraction.

It is well then that observers equipped by the nations of the earth engage in this the most sublime of problems. The transit will begin on December 6th at 8:40 A. M., and pass off at 3:14 P. M. Washington mean time. We have no longitude of Kansas City, but making a guess from an ordinary map conclude that it is 18 degrees, or 1 hour and 12 minutes from Washington; hence the transit will begin there at 7:28 A. M., the Sun rising at 7:02. This observatory is in preparation to observe the phenomenon. Anybody can see Venus on the Sun with a smoked glass.—*Kansas City Review.*

New Windsor (Illinois) Observatory, July 17, 1882.

## DRYING GELATINE PLATES.

J. J. S. BIRD says, in a communication to the Bristol and West of England Amateur Photographic Association: An inconvenience which has caused no little trouble to workers with gelatine plates is the length of time they take to dry. A collodion plate can be held to the fire and dried in a very short time; but a gelatine plate under the same conditions would melt and run. Now, a gelatine plate may, under different conditions, be dried quite as rapidly as a collodion plate; and I have frequently taken a negative, dried it, and printed a proof in considerably less than half an hour.

The principle is simply to remove the superfluous moisture before holding the negative to the fire, and this can be done by applying a piece of perfectly clean blotting-paper to the surface of the gelatine, using at first a moderate pressure, and increasing this pressure to any degree required. The blotting-paper will in *no way* injure the negative, and any stray pieces of fluff will dust off when the plate is dry. Still, it is better to carefully dust the blotting-paper and to remove any stray pieces of material before it is applied. It will now be found that the negative can be dried at any degree of heat in the space of from thirty seconds to two minutes. This fact led the writer to the following:

If a gelatine negative be dried as above, at only a moderate heat, it will not perceptibly differ from a negative which has been allowed to dry spontaneously; but if a negative from which the superfluous moisture has been extracted by blotting-paper be exposed to a greater heat, the whole complexion of the negative is altered. Not only does the film become horny and tough, but the picture on it appears in *relief*—so much so that it seems to me quite possible to produce a cast from the negative capable of being printed from in an ordinary press. This is an extension of the principle referred to in this year's annuals, in which hot water is used as a *developer;* but this does not seem either as simple or efficacious as the method I suggest above. At all events, I think the matter is worthy of the consideration of this society, and I commend the hints to my fellow members.—*Br. Jour. of Photo.*

## REDUCTION OF CERTAIN ORES OF SILVER IN THE MOIST WAY BY HYDROGEN.

By M. P. LAUR.

WHENEVER hydrogen takes its rise in a liquid containing silver sulphide, chloride, bromide, and iodide, the silver compound is destroyed, and the silver is deposited in the metallic state. The following reaction may be utilized in metallurgy: The silver ore is ground to a fine powder, and put in a cast-iron vessel, into which is poured a weak alkaline lye, 1 part soda to 100 parts water. There is also prepared an amalgam of 3 parts tin to 100 parts mercury, which is added to the ore, and the whole is raised to a boil. The hydrogen decomposes the argentiferous compounds. The silver amalgamates with the mercury, the sulphur passes into the liquid as an alkaline sulpho-stannate, while the chlorine, iodine, and bromine give corresponding sodium salts. There is no appreciable loss of mercury. This reaction might be usefully substituted for the Mexican "Cazo" and the Californian "Pan" processes. The waste of mercury is suppressed, and the extraction of the silver is more complete.

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